VOLUME 66 • NOVEMBER 1957 • NUMBER 5

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Arthur J. Fischer

The Occlusal Film
Ralph J. Caparosa and Albert R. Zavatsky

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Vascular Labyrinthine Syndromes in the Light of a New Technique
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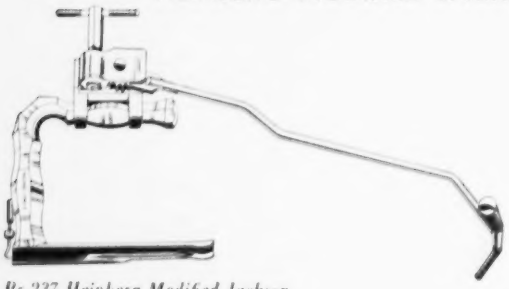

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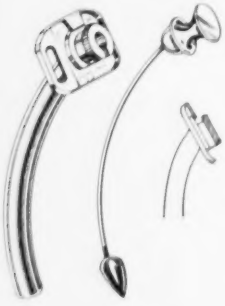

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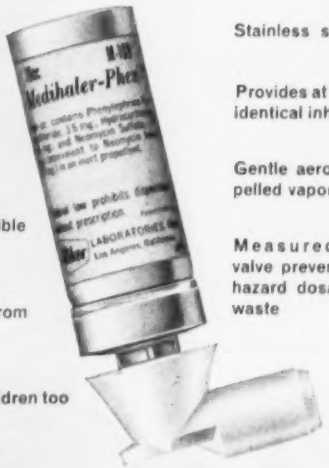

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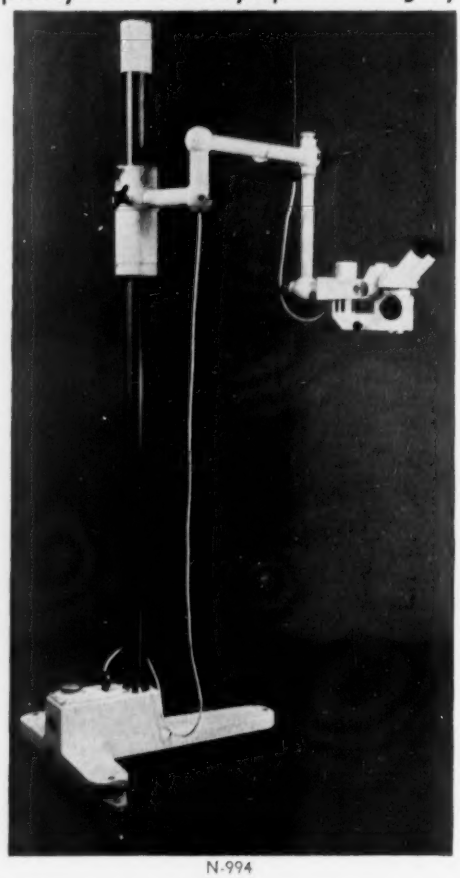

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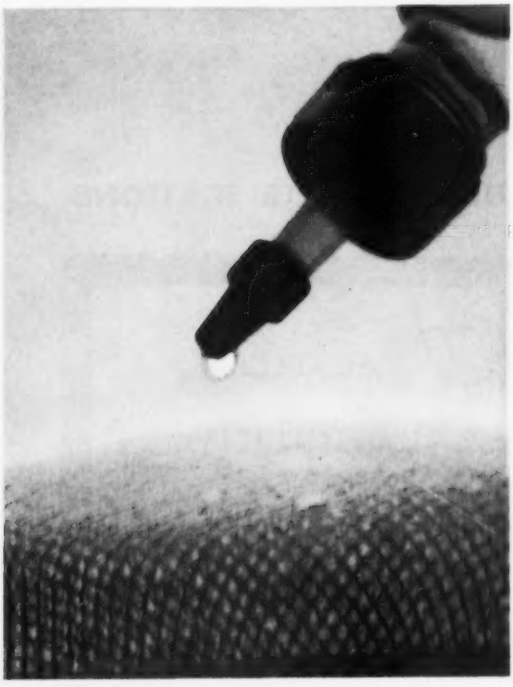

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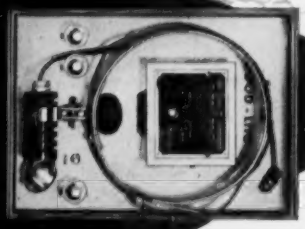

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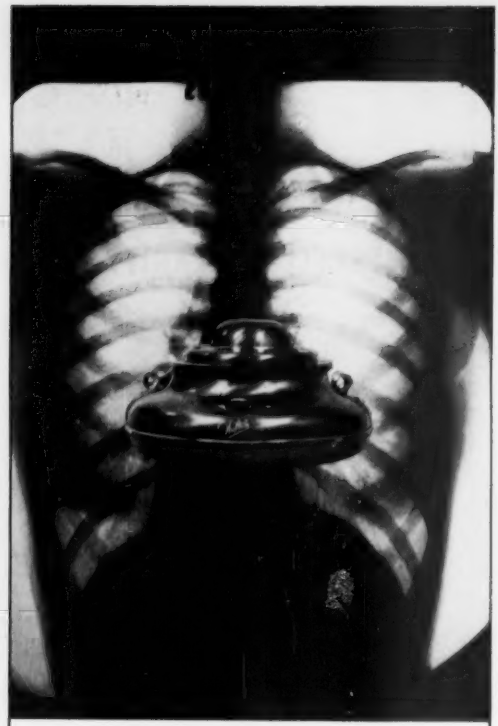

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Nasal Surgery in Children

ARTHUR J. FISCHER, M.D., Pittsburgh

The problem of nasal surgery in children is one of the most challenging ones with which all of us engaged in otolaryngologic practice must contend. The purpose of this presentation is to offer our experiences, to explain what we believe are the indications for such surgery, and to describe the various surgical techniques used.

Of a total of 1118 elective nasal operations performed from 1948 through 1955, a total of 108, or 9.7%, have been done on children between the ages of 4 and 16. Figure 1 shows the age distribution. In all instances a submucous resection of the septum was performed. Other procedures such as reduction of nasal fractures and rhinoplasties were carried out as indicated.

Accepted for publication March 10, 1957.

Indications for Surgery

Figure 2 shows the various reasons for which the surgery was done. In many instances the indications were multiple, but for simplicity only the most important reason is tabulated. For example, a child is presented because of recurrent epistaxis, and in the course of the examination secretory otitis media and nasal obstruction are found. Only the epistaxis is listed because that is the primary reason for the patient's treatment. The need for complete and careful examination cannot be stressed too strongly. A mere glance at the anterior portion of the nose is not enough. The septum should be observed throughout its entire length. This is usually quite easily accomplished in older and cooperative chil-

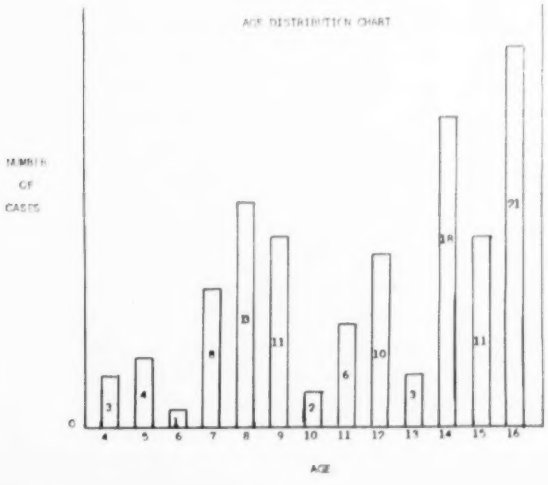

Fig. 1.—Age distribution chart.

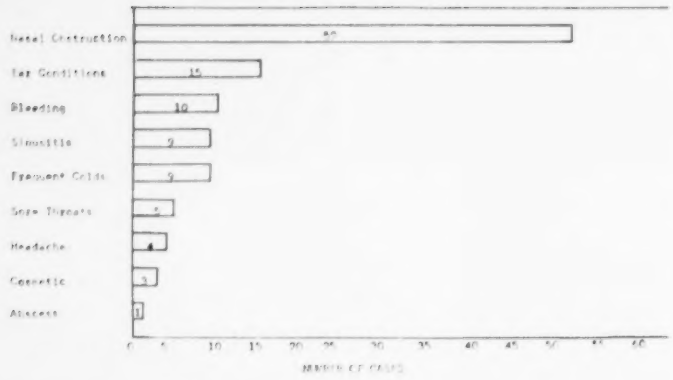

Fig. 2.—Reasons for nasal surgery.

dren by means of inserting pledgets of cotton soaked in some mild shrinking solution or instilling the solution directly into the nose. The younger and more obstreprous youngsters must be forcibly restrained.

1. *Nasal Obstruction.*—As you can see, obstruction to nasal breathing was by far the commonest complaint. I feel certain all of us have performed tonsillectomies and adenoidectomies on children for the express purpose of improving nasal breathing, only to have the child return a few weeks or months after the surgery with the same complaint. At this examination we find that the real cause of the trouble is a badly deviated nasal septum. Such situations prove rather embarrassing and may have vast repercussions. Likewise, we have had contact with children who have been thoroughly desensitized to their various allergies and still are unable to breathe nasally. Again we find that the problem is actually one of septal obstruction.

2. *Ear Conditions.*—All children who have any difficulty whatsoever with their ears deserve a thorough and complete nasal examination. Acute or chronic suppurative otitis media, as well as the secretory conditions, is often associated with some form of nasal obstruction. Certainly all patients with any kind of hearing difficulty should have their noses adequately checked.

3. *Nasal Bleeding.*—Most of us have had the experience of being called upon to treat recurrent nasal bleeding in children. Very often we shall discover that the bleeding area is located on the convex side of an anterior septal deviation. All attempts at chemical cauterization fail. Electrocoagulation can be accomplished under local anesthesia only in older and more cooperative children. General anesthesia must be used on younger and difficult cases. The necessity of repeated cauterization and the hazard of using open cautery around flammable anesthetic material soon wean us away from such procedures. Correction of the septal bend, thereby releasing the tension of the offending vessel, is, alone, often sufficient to stop the bleeding permanently.

4. *Sinusitis.*—One of the requisites for healthy sinuses is the accomplishment of adequate aeration and ventilation. Such is hardly possible when the middle meatus is blocked by septal deviation or turbinate hypertrophy. All the local treatment, punctures, instillation of antibiotics, sinus surgery, etc., are not going to clear up the sinus condition permanently unless normal nasal function is restored. As a matter of fact, probably one of the main reasons that sinus surgery has enjoyed such a poor reputation in the past has been that the nasal obstruction, which was instrumental in causing the sinus disease, was not corrected at the time of surgery.

5. *Frequent Colds.*—This is extremely difficult to explain on the basis of nasal obstruction alone. Other factors are undoubtedly present. Nevertheless, nine such

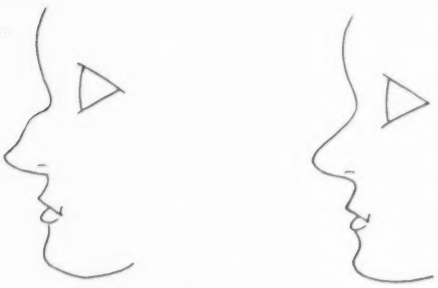

Figure 3

cases were encountered, and satisfactory results were obtained.

6. *Sore Throats.*—Most of us have seen children who continue to have sore throats even after careful tonsillectomy and adenoidectomy and also after allergy and true sinusitis have been eliminated. We find thick mucoid or mucopurulent postnasal discharge. Septal deviation seems to cause retention and stasis of these secretions, thereby contributing to repeated pharyngitis.

7. *Headache.*—This can be a very distressing symptom in children, too often with grave foreboding. Unfortunately a number of these children are subjected to various neurosurgical procedures, some of which are not without danger, only to get negative findings. Not infrequently septal interference with proper sinus ventilation can be the sole cause of the patient's headaches. Also septal impingement on the middle turbinate can produce a sphenopalatine ganglion type of pain which is relieved by surgical correction of the septum.

8. *Cosmetic Reasons.*—All of us are aware of the seemingly inherent cruelty of children. Certainly there is no better candidate to vent this part of their nature upon than another child with an extremely ugly and deformed nose. Such ridicule invariably has dire psychological consequences and can well lead to later psychopathic states. It is folly to attempt a rhinoplasty and not correct the septum at the same time. Furthermore, in some instances, if the septum is not corrected, it may in time bring the mobile part of the nose back to its original displaced position, thereby necessitating further surgery.

Figure 3 illustrates a case the author had the opportunity to care for. At first glance, this nose is the typical boxer type of deformity. However, examination revealed the deformity to be soft. With the patient under general anesthesia, through a rhinoplastic type of incision, starting at the lower border of the upper lateral cartilages, I encountered and removed a partially organized hematoma. Undoubtedly, had this been left alone, it would have undergone extensive organization with possible ossification and would have required a complete rhinoplasty. Furthermore, the child would have been subject to ridicule until such time, if ever, that it was corrected.

Figure 4 shows that even though you performed a very fine and adequate submucous resection of the septum, the patient still could not possibly have adequate breathing space. In such a case a rhinoplasty is essential.

9. *Abscess.*—Only one such case was encountered. The abscess was the result of an injury to the septum which became infected. Both nasal fossae were completely

Fig. 4.—*A*, preoperative condition. *B*, submucous resection alone. *C*, submucous resection and rhinoplasty.

occluded. A drainage incision was made at the anterior part of the septum, and the abscess was evacuated. Through this incision it was found that the cartilage was so badly displaced that if it were left uncorrected the nasal fossae would still be badly blocked, so it was decided to correct the obstruction through this one incision. Such was readily accomplished, and recovery was uneventful with no resultant deformity of the nose or nasal septum.

Causes of Septal Deviation and Nasal Deformity

The causes of nasal deformity and septal deviation are divided into two main categories, namely, congenital and traumatic. We find that the white race is by far the more commonly affected. In Caucasians the nose develops more prominently than in the yellow races or in Negroes. Furthermore, certain families tend to have similar external and internal deformities. Have you not had the experience of suggesting nasal surgery to a patient and have him remark that it was necessary for his father or some other close relative to have the same operation?

All of us realize the prolonged and forceful stress that the nose must undergo during the birth process. Very often the septum is dislocated at this time. Most such dislocations return to normal after a few hours or days. However, a certain number stay in this malposition and may cause symptoms in later life. Some institutions have all newborns examined by the otolaryngological resident, and, if such deflections are encountered, they can readily be reduced by rocking the septum back into the maxillary groove with a blunt instrument.

We can further divide the traumatic causes of septal deviation and nasal deformity into major and minor categories. By minor injuries we mean those that cause no apparent deformity or dislocation. However, such injuries stimulate the growth of cartilage and bone and may result in changes that can produce pathological findings in later life. Major injuries include fractures of the nasal bones and/or fractures or dislocation of the nasal septum. Huffman,[1] as well as many of us, has found that actual fracture of the nasal bones in very young children—say under 6 years—is rather unusual. Most severe injuries to the nose in these patients involve the cartilagenous structures, most often the septum.

Aagesen et al.[2] are very positive in stating that all children with the history of a nasal injury, especially if there is any evidence of a nasal fracture, should be thoroughly examined as soon as possible even if it means examination under general anesthesia. This point cannot be too strongly stressed. Permission should be obtained from the parents at this time to perform whatever procedures are deemed necessary. Very often simple procedures such as evacuation of a hematoma, or reduction of a fracture or dislocation, can avoid more extensive surgery in the future. Unfortunately, all injuries to the nose cannot and will not be examined and corrected. It is highly impractical, realizing how many bumps on the nose a toddler gets in the course of a year, to take him to a doctor on each occasion. Such coddling is unnecessary; however, the more severe injuries should be examined. Most often nothing need be done, but, if correction is imperative, there should be no delay.

Surgical Technique

Anesthesia, which is usually such a controversial subject, does not present much of a problem here. I have used general anesthesia, namely, tribromoethanol (Avertin)-ether, exclusively. Certainly there is no objection to thiopental sodium (sodium pentothal) in older children. Peer[3] advocates general anesthesia exclusively for this type of work.

Careful handling of nasal fractures is of utmost importance. For medical-legal reasons, all cases of severe nasal injury should have an x-ray taken to determine the pres-

ence of fracture. However, from here on the surgeon should rely on his clinical findings alone. Many times the report will read, "Evidence of fracture of the nasal bones but the fragments are in good position and alignment," yet clinically the nose is clear out of position. Another report is "No evidence of nasal fracture," yet clinically you can take and move the nose freely and produce all the classical signs of fracture. It is advisable, after reduction is accomplished, to splint the fragments internally with packing or Simpson splints and also externally with a dental compound or metal splint. A hematoma of the septum should be evacuated,[2] and a rubber tissue drain inserted in the septal incision for a few days. If the septum is dislocated, it is usually very easy to reduce it at the same time by the use of blunt instruments or Asch forceps. Actual septal deviations should be corrected at the time of fracture reduction. Very often the septal deviation was present before the nose was fractured. This should be explained to the family and then one should proceed with their permission. It is very difficult to convince them of such a situation six months later. If saddling occurs,[2] it should be repaired in six to eight months by cartilage implants. Peer[5] advocates autogenous cartilage for children.

The problem of the actual submucous resection in children is a challenging and fascinating one. Each case must be individualized and handled in the manner best adapted for the particular patient. There are not and cannot be any dogmatic rules. For instance, Lierle and Huffman[1] in giving their five objections to the Killian submucous resection state that it is not adaptable to children. I have used the Killian procedure on many children when there was no disturbance of the anterior end of the septum. Septal spurs, ridges, and posterior deviations can be adequately removed by that method. Some authors object to the Fomon and Galloway techniques, holding that they impart stiffness to the columella. This can be avoided by fashioning the pocket a little farther back and at the same time not permitting the cartilage transplant to enter any part of the membranous septum.

Cartilage graft loss is not often encountered. Autogenous grafts take almost perfectly. I have not, to this date, had any cartilage liquefied or extruded. Homogenous or heterogenous grafts also do well but autogenous cartilage is by far the safer and more satisfactory.[5]

The question of how much cartilage or bone to remove must be considered. Cohen[4] removes only an anterior-posterior sliver at the angle of deflection. Actually there is no rule of thumb in this matter. The patient wants to be able to breathe freely or to have his sinus condition corrected, or to have his nasal bleeding ended, and he doesn't want to have it done in stages. You must remove as much cartilage and bone as is necessary, that is, to produce a perfectly straight septum without tension. It is the failure to do a complete and adequate job the very first time that has given septal surgery the doubtful reputation that it has had in the past. Any of us who have attempted secondary submucous resections know how difficult and often impossible it is to get a good result. I by no means condone radical or excessive removal of tissue but rather advocate removal of the least amount that will give the desired result.

It is not wise to depend on packing and sutures to maintain the desired position, because, shortly after the packing has been removed, a septum that has been improperly operated on will assume a malposition. I believe that in children it is best to suture the septal incision in all cases. Silk, cotton, and other removable material may be used. The very fact that such sutures must be removed bespeaks well for the absorbable type. Some children require restraints and even an anesthetic for removal of sutures, and unless you have a quiet patient, a certain amount of injury can result. Fine, plain absorbable surgical suture (catgut),

such as 00 or 000, seems to be more practical.

Packing, of course, is essential. The type of packing, though, is subject to vast variation. Formed splints, such as the Simpson or Dickinson variety, can be used alone or in combination with plain gauze petrolatum or gauze impregnated with cod liver oil or some related preparation. It is not wise to pack the nasal fossae too tightly because of the danger of pressure necrosis. Furthermore, when most of the cartilage and bone of the septum remain, snug packing is not so essential. Usually all the packing is removed by the second postoperative day, and by the third day the patient is able to be discharged from the hospital.

If any complications occur, such as hematoma or abscess, the patient should be returned to the hospital. Ordinarily in adults such problems can be handled adequately in the office but in children this is not advisable. Preservation of the cartilage is too important in children to take a chance. Under anesthesia, the septal incision is opened, the contents aspirated, a rubber tissue drain inserted, and the nasal fossae repacked. Antibiotics must be given in large doses. The patient should not be discharged until you are certain that any danger of recurrence has passed.

As far as rhinoplasties are concerned, it is a good functional result that is important primarily, and an acceptable cosmetic result secondarily, regardless of what has to be done. Children themselves do not want to be beautiful; they merely want an inconspicuous nose that will free them from ridicule. Nevertheless, the operator must be capable of handling all rhinoplastic procedures in order to cope with the situations as they arise. A thorough understanding of the nasal valve mechanism and the methods of handling the malfunctioning variety is essential. Otherwise, you are going to encounter patients on whom you have performed a good rhinoplasty and provided a straight septum, and yet they cannot breathe through their nose. Median and lateral osteotomies can and must be performed when necessary—care always being taken to preserve as much periosteum as possible. The lower lateral cartilages are best left alone[4] unless the deformity is gross. The nasal tip changes with age more than any other part of the nose, and it is best to wait until adult development is attained before tampering with the lower lateral cartilages.

Summary and Conclusions

The broad problem of nasal surgery, especially septal surgery, in children has been discussed from the standpoint of indications, etiological factors of the obstruction, and the various surgical techniques used. An analysis of 108 consecutive cases operated upon by me is presented. It is earnestly hoped that more men will take an interest in this highly controversial phase of our specialty.

220 Alcoa Building (19).

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The Occlusal Film

An Adjunct to the Roentgen Diagnosis of Nasal Fractures

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Usually the diagnosis of a nasal fracture is readily made from the patient's history and physical examination. The use of x-rays, however, is valuable and strongly recommended in every case. Its importance as a permanent record—whether positive or negative—is unquestioned in cases of litigation. Roentgenograms are useful in delineating the nature of the fracture pathology and are prerequisite to satisfactory therapy.

Roentgen examination for the diagnosis of nasal fractures routinely includes the right and left laterals, the A-P Water's, and, in some cases, the occlusal view. A paucity of literature referable to this latter view led to a recent study which elicited its immense value.

Diagnosis

The clinical diagnosis of a nasal fracture can be made with little difficulty. Any case of nasal trauma followed by epistaxis should be suspected as a possible nasal fracture. The presence of a nasal deformity which was not previously manifested confirms this diagnosis. The absence of a deformity, however, does not rule out a nasal fracture since overlying edema may obscure the true bony pathology.

The roentgen diagnosis corroborating the clinical opinion, is, likewise, usually not difficult. In a series of 72 adult cases [1] in which a clinical diagnosis of nasal fracture was made at the U. S. Army Hospital, Nuremberg, Germany, all 72 exhibited definite nasal fracture sites on the roentgenograms. The roentgen survey in this series consisted of both laterals, the Water's, and the occlusal view.

In a series of 100 nasal fractures, Becker [2] was able to demonstrate only 53% on roentgenograms. It is significant to note that in this series, practically one-half of his patients were children and adolescents. In these patients it is difficult to show x-ray evidence of nasal fracture, for in a great percentage of cases, the fracture pathology will involve the cartilaginous nasal vault which is not seen roentgenographically.

The lateral nasal x-ray view is the most frequently taken, and, on the same hand, the view which is most frequently interpreted. It demonstrates the actual fracture line and will show dorsal or superior displacement of the fragments, but it does not depict lateral or mesial displacement. Since a great number of nasal fractures occur as the result of trauma from the lateral aspect, it is most important to determine any lateral or mesial deviations of the nasal bones. Frequently this lateral view is reported, "a linear fracture of the nasal bones without significant displacement." The clinical findings may contradict this impression, for the patient may exhibit a definite external nasal deformity, or an occlusive film may demonstrate the true pathology. In some cases late subsidence of edema may mask the true deformity for many weeks. In any event, the attempt to establish roentgenographically traumatic displacement by employing only the lateral views might be encountered with ridicule in cases of litigation.

Fig. 1.—Technique for the occlusal film.

Accepted for publication April 5, 1957.

Technique

X-rays are projected from a cephalad source after a bite film is placed in the patient's mouth between the occlusal surfaces, thus producing an occlusal film (Fig. 1). Actually the central ray is directed through the nasal bones in a tangential plane drawn from the midfrontal prominence to the upper incisive teeth, and in such manner

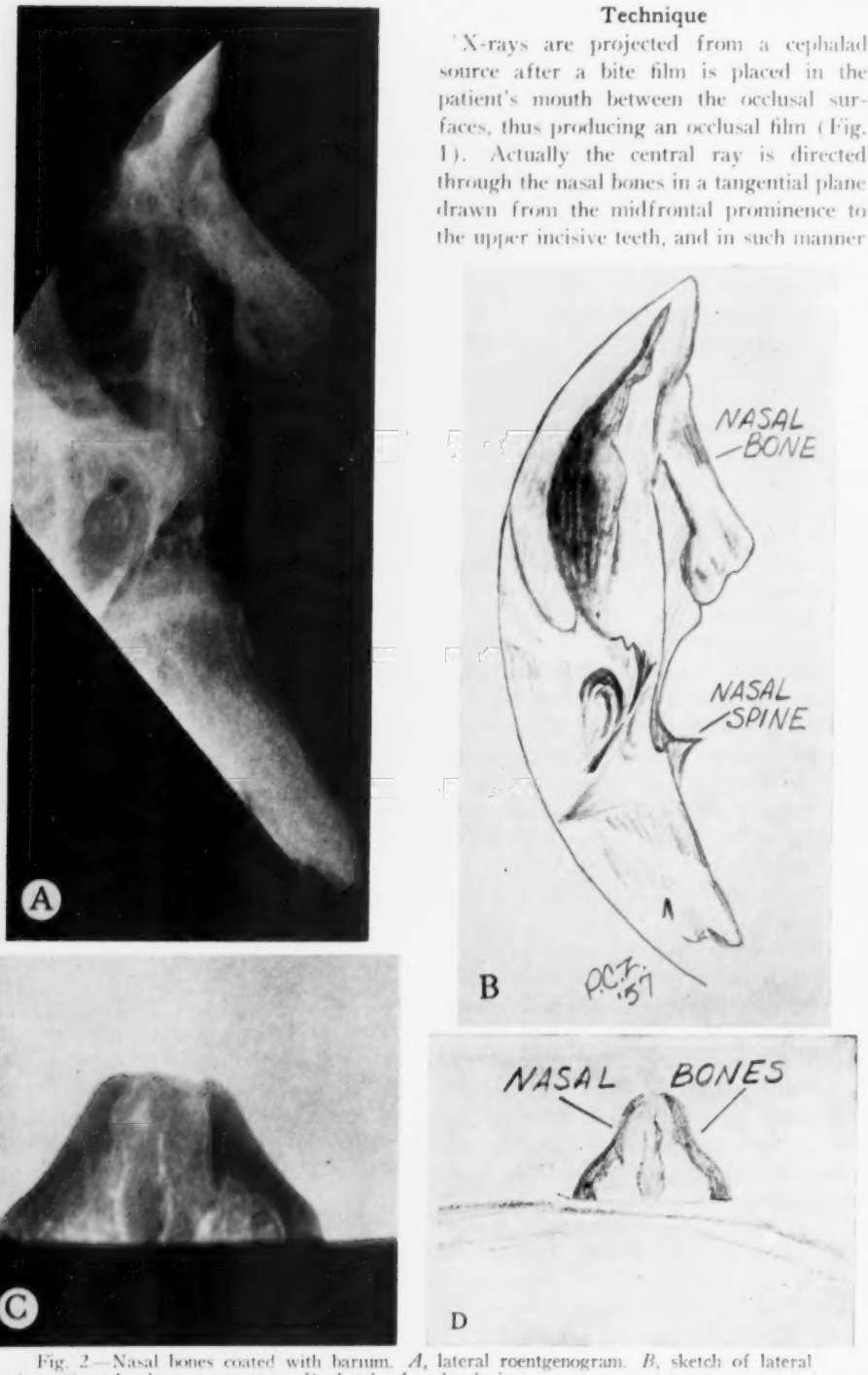

Fig. 2.—Nasal bones coated with barium. *A*, lateral roentgenogram. *B*, sketch of lateral view. *C*, occlusal roentgenogram. *D*, sketch of occlusal view.

as to present their superimposition upon the soft tissue shadow of the lip.

In order to demonstrate the normal details seen on an occlusal view as compared with the lateral view, nasal bones of a skull were x-rayed. A light coating of barium paste was applied to the nasal bones to accentuate the roentgenographic impression. The details of the resulting view were then properly identified (Fig. 2).

The occlusal view is a desirable adjunct to the roentgen diagnosis of nasal fractures. Its use is limited, however, by the configuration of the nasal bones and adjacent bony structures. It was shown that one could determine from the lateral view whether or not a diagnostic occlusal film could be taken of specific nasal bones. A straight edge is placed, or a line drawn, between the mid-frontal prominence and the upper anterior incisor teeth on a lateral roentgenogram. If the nasal bones project sufficiently beyond this line, then satisfactory occlusal film should be possible. On the other hand, if the projection of the nasal bones is not adequate, then a diagnostic occlusal view would be technically impossible (Fig. 3).

Fig. 3 (pp. 505 and 506).—Lateral views and sketches demonstrating the limitations of the occlusal film. *A* (above), satisfactory occlusal is possible.

B (left and above), satisfactory occlusal is not possible.

The case illustrations demonstrate the limitations of lateral roentgenograms and the necessity of utilizing the occlusive film to determine lateral or mesial fragment displacements. The great value of this technically simple diagnostic film can readily be appreciated from the following illustrations, which are only four of many that were encountered in a large series of nasal fractures.

Summary

The occlusal roentgenogram is the best view available to determine lateral or mesial displacement of fractured nasal bones. The technique, anatomic demonstrations, and the limitations are presented. Appropriate case illustrations are also presented to corroborate the value of this view.

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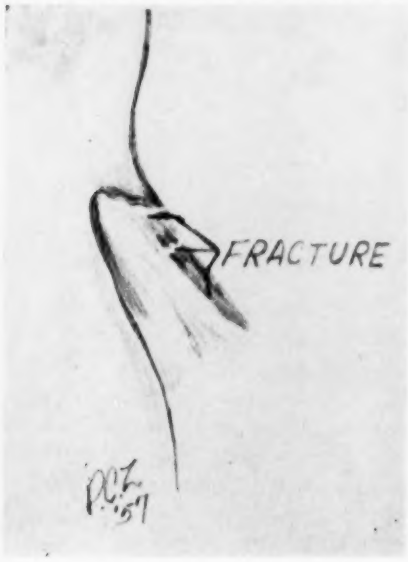
Fig. 4A.—Lateral roentgenogram and sketch demonstrating nasal fracture.



Case Illustrations

CASE 1.—Figure 4A represents a lateral roentgenogram showing a nasal fracture indicated by the arrow. This lateral roentgenogram was reported as, "linear fractures thru the bridge of the nose, which appears to be in satisfactory alinement. The Water's view revealed no evidence of any fracture." Clinically there was a depression of the left nasal pyramid. This bony pathology was then accurately demonstrated only in the occlusal view (Fig. 4B). Here it is noted that there are not only linear fractures of the left and right nasal bones, but also marked depression with encroachment upon the nasal vaults.

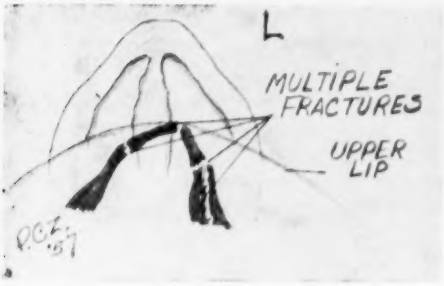
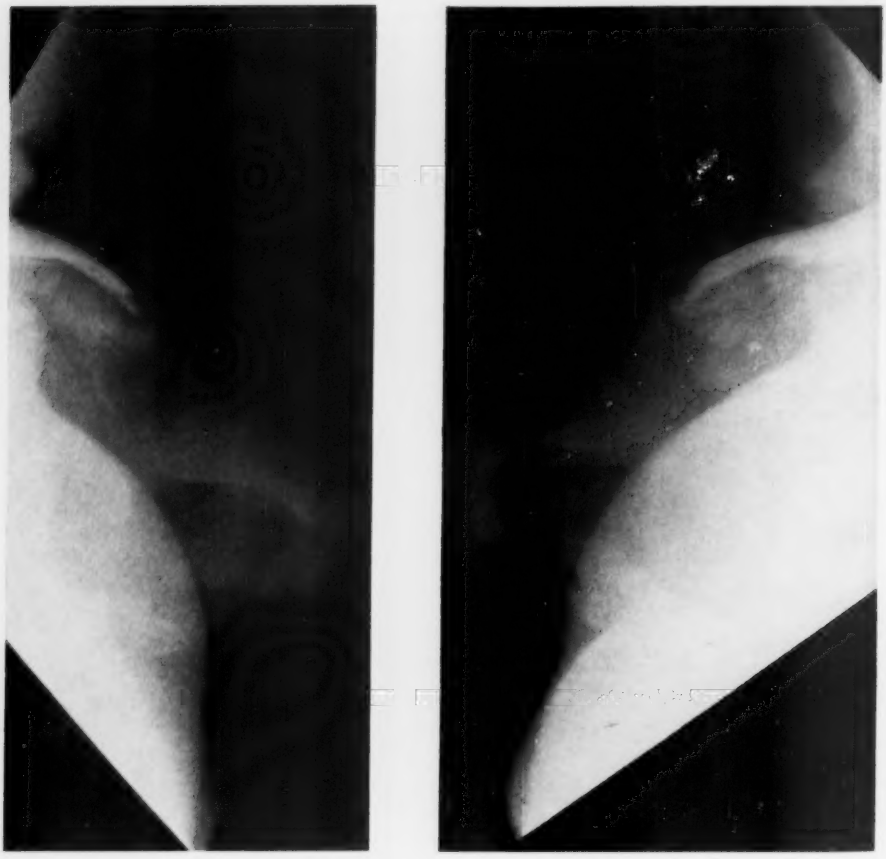


Fig. 4B.—Occlusal roentgenogram and sketch depicting true pathology.



CASE 2.—Figure 5A represents lateral roentgenograms showing a nasal fracture indicated by the arrow. This linear fracture was reported to be in satisfactory alinement. Clinically, diffuse edema obscured the true external appearances and underlying nasal deformity. The occlusal film (Fig. 5B), however, depicted the true nature of the fracture pathology. There is a fracture of both nasal bones with depression and encroachment of the right nasal vault.

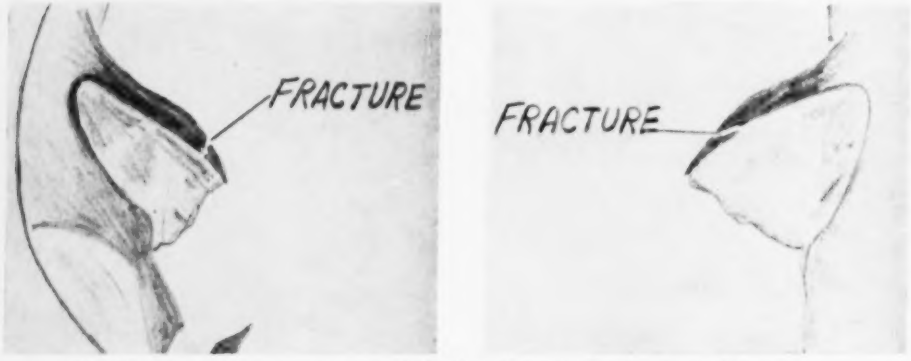


Fig. 5A.—Lateral roentgenograms and sketches demonstrating linear nasal fracture.

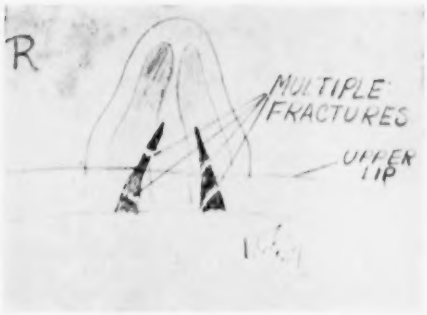


Fig. 5B.—Occlusal roentgenogram and sketch depicting multiple fractures of each nasal bone.

CASE 3.—Figure 6A represents the lateral roentgenograms demonstrating the linear nasal fracture indicated by the arrow. The fragments appear to be in good alinement. The occlusal film (Fig. 6B),

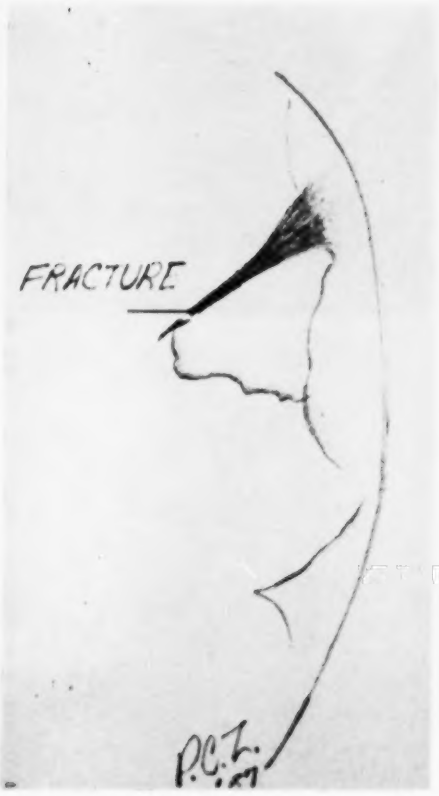
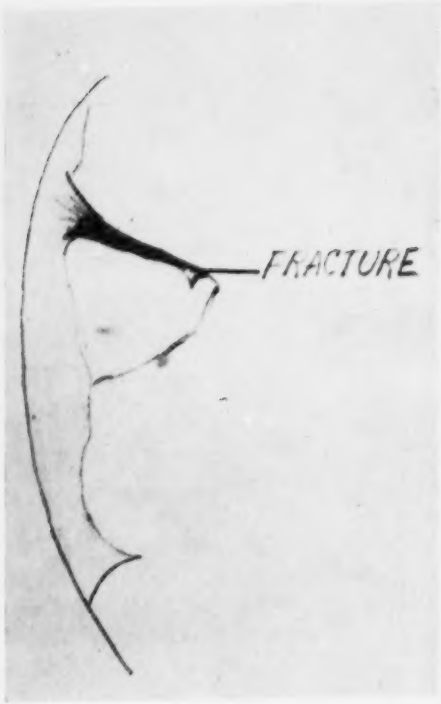


Fig. 6A.—Lateral roentgenograms and sketches demonstrating fracture.

however, demonstrated the true bony pathology, with a fracture of the right nasal bone, multiple fractures of the left nasal bone, and encroachment of the left nasal vault.



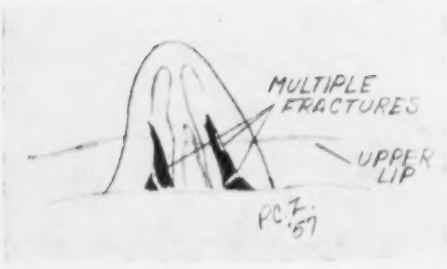


Fig. 6B.—Occlusal roentgenogram and sketch depicting true fractures.

Fig. 7A.—Lateral roentgenograms and sketches demonstrating linear fractures.

Case 4.—Figure 7A represents the lateral roentgenograms exhibiting linear fractures indicated by the arrows. The fragments appear to be in good alinement. The occlusal film (Fig. 7B), however, demonstrates the fracture of the right nasal bone with overriding, and the fracture of the left nasal bones with respective encroachment upon the nasal vaults.

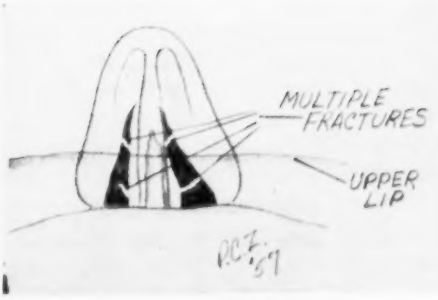


Fig. 7B.—Occlusal roentgenograms and sketches depicting the fractures with encroachment.

The Question of the Origin of the Vibrations of the Vocal Cords

A Clinical Contribution

EMIL FROESCHELS, M.D., New York

In the last few years R. Husson has spent a tremendous effort and has shown great mental audacity in his attempt to correct the theory of the nature of the vibrations of the vocal cords. Before Husson stepped into the arena it was almost the general opinion that the vibrations of the vocal cords are initiated by the stream of air, and that the swinging back is due to the elasticity of the cords. Tonndorf [1,2] taught that the vocal cords, moved up and outwards by the air, are sucked back by the attenuated air, the attenuation resulting from the stream of air that has been used for the upward and outward movements of the cords. The function of the recurrent nerve was considered to consist of innervating the muscles that open and close the glottis. The cranial branch of the pneumogastric nerve, according to this theory, innervated the cricothyroid muscles, so helping to elongate the vocal cords (Negus [3]). In high notes the cranial branch thus produced a strong stretching of the cords.

This theory is called the myoelastic or aerodynamic-muscular theory. It does not seem necessary to go into more detail since it is not my intention to discuss Husson's theory from a physiologic viewpoint. His theory [4] is called the neuromuscular or neurochronaxic theory. According to his theory every single voice vibration is due to a single impetus from the recurrent nerve and not to the air pressure. This function of the recurrent is said to be stimulated in the speaking voice by the cortex of the brain. The acoustic center regulates the pitch. In the speaking voice the impetuses are sent out by the thalamus opticus and the striatum. Experiments on dogs by Laget [5,6] and on the human larynx by Moulonguet [7] showed that rhythmical electric stimulations of the recurrent produced vibrations of the vocal cords in the dog, and that the changes of the electric potential in the recurrent nerve in man during the tone production were identical in number with the vibrations of the cords. It is not necessary in this paper to pose the question whether these changes of the electric potential of the recurrent do not derive from centripetal stimulations (Lindenmann,[8] Van den Berg [9]), since the recurrent contains also sensory fibers.* That the theory of Husson is also called neurochronaxic is understandable since the number of impulses going from the nerve to the muscles depends on the chronaxy of the nerve.

The part of Husson's ideas mentioned above might suffice for the understanding of my own contributions to the subject.† However, it must be mentioned that, as he well deserves, Husson has been praised by several writers for his endeavors to reconsider the nature of the vibrations of the vocal cords and for his numerous most interesting findings. I want to join those writers in giving credit to Husson and to his collaborators ‡—Garde, Laget, Chenay, Dijian—to Lille-Piquet [12] and others—as

Accepted for publication March 10, 1957.

* See also Lullies, H.: [10] Physiologie der Stimme und Sprache.

† A recently published pamphlet by Panconcelli-Calzia [11] offers an excellent survey on the neuromuscular theory.

‡ See Index bibliographique in article by Husson.[4]

well as to the past initiator of the neuromuscular theory, Heymann.[13] (Here I want also to mention that Stern[14] was a predecessor of Husson.)

The opponents of the neuromuscular theory, Vallancien,[15] Van den Berg,[9] and, from an anatomic viewpoint, Wustrow[18] (who opposes Goerttler's[20] opinion about the anatomic structure of the vocal cords), and, furthermore, Kagen and Luchsinger[21] can only be mentioned here. It does not seem necessary to describe the viewpoints of the opponents, because they are concerned with physiology and anatomy while the problem will be approached here from a clinical angle. The reader interested in the literature concerning Husson's theory will find exact information in the report of Berendes[22] on troubles in the movements of the vocal cords.

I want to raise the following question here: Is Husson's theory in its present formulation capable of explaining the well-known fact, mentioned in many textbooks, that many patients with bilateral paralysis of the recurrent nerve have no or only a not severe voice impediment if the cords are fixed in median or paramedian position? Husson recently[23] pointed out that, according to the findings of Madame Hoffmann, the nerve consists of three bundles. This fact could, in his opinion, explain that in some cases of paralysis of the posticus a relatively good voice shows if the bundle innervating the thyroarytenoid is still in a workable condition.

I remember, among others, a female patient in Vienna after bilateral thyroidectomy sent to me by the surgeon for treatment. The surgeon reported to me that both recurrent nerves had been severed during the operation. The vocal cords were fixed in paramedian position. Breathing difficulties were so severe that tracheotomy was impending. D. Weiss,[24] at that time a clinical assistant of mine, suggested using the so-called pushing exercises[25,26] which I had introduced for treatment of paralysis, or paresis, of the velum. With pushing exercises tracheotomy could be prevented. The voice of the patient was good, and she reported that she did not notice any change of the voice after the operation. I have seen several similar cases with identical findings, namely, severe breathing difficulties, the cords immobile in median or paramedian position, and no voice trouble. Anyway, the patient described above is of special importance for the topic of this paper because the surgeon was sure he had severed both recurrent nerves. (This nerve is sometimes situated so that the surgeon may not be sure whether or not he has really severed it entirely.) Since I did not want to rely exclusively upon my own experiences, I interviewed a high-ranking authority, Dr. De Graaf-Woodman, who has given permission to publish here his answers to my questions. My first question was as follows: "Have you seen cases without voice troubles whose cords were fixed in median or paramedian position?" Answer: "Hundreds." Second question: "Do you have reports of surgeons indicating that the recurrent nerves have been severed?" Answer: "Yes, that is nothing extraordinary."

Whatever the reports of the surgeons may be, it is very probable that among the very numerous cases with cords fixed in median or paramedian position there were some in which the nerves were really severed. However, probability is not scientific proof of an assumption in medicine (it may be different in nuclear physics). Pathologic-anatomic findings are necessary. I had very little hope of finding pertinent cases in the literature. It was not probable that death occurred as a consequence of posticus paralysis because tracheotomy would have been performed as an emergency operation. Furthermore, it seemed a priori dubious whether the pathologist would have examined the larynx if death had resulted as a consequence of an aneurysm, a tumor in the mediastinum, or damage of the central nervous system. Anyway, after studying a great deal of the literature, I found two

case histories and postmortem reports which indicated that one case had an entirely normal voice, the other a voice with only an unpleasant timbre. These two cases follow: A 46-year-old woman had for months difficulty of deglutition and for two weeks before her death some voice troubles. Only two days before she died she was voiceless (Aug. 3). The laryngologist (Chiari) found on July 17 both vocal cords in cadaveric position, but wrote expressly that the voice was not hoarse, only of an unpleasant timbre. The histologic findings (Kolisko) revealed a total degeneration of both recurrent nerves. I should like to stress that two weeks previous to death the patient had no voice troubles, while the complete degeneration of the nerves cannot have occurred in two weeks. Furthermore, it seems probable that the progressive general weakness of the patient hindered her from bringing forth the energy to produce voice (as one observes sometimes in dying persons). The case is taken from the book of Deygas.[27]

The second case concerns a man, hard of hearing from birth, who immediately after thyroidectomy and for the following four years had been suffering from breathing difficulties. The laryngologist who published the case, Menzel,[28] saw him only shortly before death. He found the right vocal cord in median position, perfectly immobile. The left one was also in median position but could at times make minimal ab- and adduction movements. Tracheotomy was done. A few days later the patient died of an intercurrent disease. Menzel stresses that the voice was always normal, a fact also given in the surgeon's report. The postmortem findings were as follows: The recurrent nerve of the right side could be isolated well in its lower two-thirds but loses itself on the border between the upper and the medial third into solid scar tissue. This tissue covered the lateral surface of the trachea and could be separated only with difficulty. Above this scar tissue no trace of the nerve could be seen. Also the left recurrent could be isolated only to about the same height. The nerve had grown together with the fibrous tissue that covered the lateral wall of the trachea and lost itself in it so that nothing of the superior third of the nerve was visible. The nerve goes through the scar tissue and becomes visible again below the posterior part of the thyroid cartilage. Here the nerve consists only of a very thin string of jelly-like appearance. It branches off into the posterior and lateral muscles of the larynx. Histologic findings by Marburg (original Weigert and Weigert-Pal stains with hemalum-eosin and Van Gieson) were reported as follows: On preparations nothing is visible of nerve tissue peripheral to the scar; on the left side peripheral to the scar still some nerve fibers visible which were severely damaged. Amersbach[29] also seems to consider this case very important because he described it extensively in his Handbuch article. Menzel,§ as has been mentioned, stresses the fact that the voice was always normal.

Furthermore, I found a case by Herzog.[30] He published the postmortem findings of a female patient who, five years after thyroidectomy and tracheotomy for bilateral intermedial position, died of sepsis. The vocal cords were perfectly normal. The fact that the voice was not mentioned might be explained by the fact that the laryngologists are used to hearing inconspicuous voices in such cases. Therefore one may assume that this voice was inconspicuous. Otherwise it would have been described, particularly since even a postmortem examination was requested.

In the cases described here and in others mentioned in the textbooks the voice re-

§ I knew Menzel personally. He was a laryngologist who always showed great interest in phonetics and certainly was capable of distinguishing a normal from an abnormal voice.

mained undisturbed.‖ In my opinion one cannot assume a vicarious taking over by undamaged nerve fibers for the damaged ones, or even a taking over by the cranial branch of the pneumogastric nerve. For such a substitution, if possible at all, cannot occur suddenly, unless the neuromuscular theory could show that such an assumption is already physiologically possible.

All my attempts at reconciling in my thoughts the facts elaborated on in this paper based on the cases described with the Husson theory did not succeed. Therefore, I believe that this most interesting theory calls for some additional, perhaps experimental findings to answer certain clinical experiences.

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‖ It might be mentioned in this connection that in the case of Herzog the vocal cords were strong and certainly not atrophic, although both recurrent nerves certainly were incapable of functioning. Whether the voices after the damage of the nerve were really perfectly unchanged cannot be assured without stroboscopy before and after the operation. Anyway, people usually notice a change of their voice and also difficulties in producing it. The aerodynamic theory could easily explain voice changes, for this theory makes both branches of the pneumogastric nerve responsible for the tension of the vocal cords.

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Adenoidectomy

An Evaluation of the Original Technique

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Examination of the surgical techniques for adenotonsillectomy, as described in the medical literature during the past 75 years, discloses that adenoidectomy has received somewhat less than adequate attention. The methods of tonsillectomy, as well as the technique of most surgeons, may vary from personal preference, but, generally speaking, they accomplish a satisfactory result. In the past decade this slight has been partially corrected by recognition of adenoidectomy as a somewhat more than trivial procedure and in many cases deserving of equal if not more attention than tonsillectomy.

The Byzantine period [1] of medical history produced a record of perhaps the earliest attempt to perform an adenoidectomy. Paul of Aegina (A. D. 625-690) wrote in Greek, while in Alexandria in A. D. 640, of treatment of projections in the nasal space and upper throat area.[2] He advocated passing a ligature through a tube into the nose and pulling the end of the ligature out the mouth. The ligature was knotted at intervals to provide substance to the effort, and when the ligature was pulled to and fro the offending growths were removed. Whether this procedure was a theoretical consideration or the actual operation was not further explained and it has been left to historians to comment on the authenticity of Paul of Aegina.

Schneider,[3] in 1655, is credited with observing and describing the pharyngeal tonsil. As he was an anatomist, the significance of his discovery apparently received little attention. Santorini,[4] in 1775, discussed the pharyngeal tonsil, and it was then apparently forgotten for 100 years. Johan Czermak,[5] in 1858, demonstrated the use of laryngeal mirrors to inspect the nasopharynx but did not mention the pharyngeal tonsil with enough emphasis to receive any credit for what he saw. MacKenzie [6] in his textbook gives credit to a certain French accoucheur by the name of M. Levret for the invention of instruments for inspecting the throat and nose in 1743. In the year 1868 Wilhelm Meyer of Copenhagen noted the pathological pharyngeal tonsil and fully described it in a treatise in 1870.[7] The use of the term "adenoid vegetations" was so acceptable in its descriptive sense that it remained in the literature as the *sine qua non* in papers on this subject for 50 years. Meyer admitted to a lack of facility in the use of the laryngeal mirror, and his observations were primarily founded upon digital examination. As is often the case, Meyer noted, in subsequent travels about Europe, the presence of classical examples of adenoidism. Of these, the portrait of Don Fernando, Infanta of Spain, painted in 1524 and the bust of Marcus Antonius in the Vatican remain as the classical examples. Bertolotti [8] has pointed out the marked adenoidism of Alexander the Great.

Waldeyer, Tornwaldt, and Luschka have become standard textbook names by their respective descriptions of the anatomical areas in the nasopharynx. Of these Luschka more specifically applies to the subject matter here in that the anatomical folds of the pharyngeal tonsil are regarded as "Luschka's" tonsils in most anatomy texts. Tornwaldt [9] is best remembered by otolaryngologists for the relatively uncommon afflic-

Accepted for publication March 18, 1957.

Presented as a candidate's thesis in partial fulfillment of the requirements for membership in the American Laryngological, Rhinological and Otological Society, Inc.

tion of the bursa known as "Tornwaldt's disease."

Guye,[10] in 1884, first emphasized the importance of the effect of adenoidism in the mental and physical development of children. The classical description was called "aprosexia," literally "wet blanket on the brain." Specifically the term "aprosexia nasalis" included deficiency of hearing as a concomitant of adenoidism.

Embrylogically, the pharyngeal tonsil develops[11] from the roof of the pharynx as a part of the level of the second pharyngeal pouch. The development commences in the fourth month of fetal life, and its lymphoid accumulation is a response to local "vascularity and freedom from growth tensions."

The origin of the adenoid seems to explain its perversity through various efforts to eradicate it. Drinker and Yoffey[12] define this thesis in their description of lymphoid tissue. Basically the tissue is a mass of free cells, predominantly lymphocytes supported by reticulum cells, elastic, fibrous, and, occasionally, muscular tissue. Basically their position is not fixed, and regenerative ability is considerable. This then postulates the difficulty in adenoidectomy and clearly indicates the need for exactness and visual aid if one is to avoid the abrupt necessity for a secondary adenoidectomy in an embarrassingly short time.

According to Arey,[13] the human pharyngeal tonsil completes its development at birth or in early infancy, attaining maximum size in childhood, and usually begins to show involution after puberty. The pharyngeal tonsil differs from the palatine and lingual components of Waldeyer's ring in having its surface scored by deep longitudinal furrows. They first appear in fetuses of about 90 mm. (crown-rump) length and are well devolped by the time the fetus is 150-175 mm. in size. Crypts as noted in the palatine tonsil are not present embrylogically in the pharyngeal tonsil.

Anatomically the various shapes and sizes of the nasopharynx together with the inconstant location of the lymphoid tissue constitute the real obstacle in performing a satisfactory adenoidectomy.

Meyer performed his adenoidectomy with a ring curette of his own design. This seems to be the original curette from which modifications of various types were later developed. This instrument was slender in the handle and the curette was of small size to facilitate introduction through the nares for the performance of adenoidectomy. The tissue was cut by repeated curettage and was either blown from the nose or fell into the oropharynx, where it was spit out.

For some years I have noted a number of children in whom the residual adenoid tissue was grossly evident to both parent and physician and naturally required removal or was accompanied by repeated attacks of acute otitis media with its unpleasant sequelae. These early cases of inexpert adenoidectomy fall to every specialist's lot with some regularity. Suffice it to say that no small amount of restraint is required in dealing with both parents and referring physician. In evaluating these cases postrhinoscopic examination was done in all but the most recalcitrant patients, and anterior rhinoscopy, following appropriate shrinkage, in all. The obvious midline lymphoid mass of the hurried and casual adenoidectomy does not need description nor does it have its place in this discussion.

Postrhinoscopic examination of the majority of these patients revealed various amounts of adenoid remnants in the roof of the nasopharynx and just posterior to the vomer.

When these patients came to surgery for their second operation, considerable effort was expended to assure a thorough adenoidectomy. Standard technique was the use of three sizes of Barnhill curettes, visual and digital examination. The visual examination was accomplished with a Love palate retractor. After the usual two-week period these patients were reexamined. Fortunately in most cases the improvement was noticeable, and remarks to that effect were usually made. However, the anteropostrhinoscopic

examination disclosed persistent remnants and removed considerable confidence in what had been thought to be an adequate approach to adenoidectomy.

Hill [14] has estimated in a series of 914 adenotonsillectomies that 23.7% indicated a poor adenoidectomy. He states that 90% of the so-called regrowths are actually remnants of incomplete adenoidectomy. Variations in the nasopharynx of children account for some of the technical difficulties, but indifferent anesthesia and unnecessary speed on the part of the surgeon are the common deficiencies. Popper [15] has described a new adenoid curette in which the plane of cutting is in the direct axis of the instrument and the blades are removable and made of razor type construction. This might eliminate one very common fault of the hospital, a dull curette.

Several authors [16-23] have presented their views in an effort to stimulate care and precision in adenoid technique. Some of these procedures have been incorporated in my changing technique over the past five years. Kyle,[24] Ashhurst,[25] Sajous,[26] and Patterson [27] either devised or used existing instruments to remove adenoids in patients through the nasal cavity. Kyle stated that the existing adenoids were located high in the vault of the nasopharynx, causing considerable obstruction, and were removed by "guiding the curette with the index finger introduced through the oropharynx."

For the past five years I have experimented with various suggested techniques and instruments as presented in the medical literature. The result of this study is the objective of this paper and includes a modification of the original approach to the pharyngeal tonsil.

It is not necessary to point out that the majority of patients requiring adenoidectomy can be handled quite satisfactorily by the oropharyngeal route, provided palate retractors and laryngeal mirrors are utilized to inspect the nasopharynx. The postnasal space, as mentioned, demonstrates considerable variation. The high palatal arch type is difficult to expose with any of the existing speculae or retractors. The taut palate in this group will not permit much tension, and undue zeal may result in a tear. The vertebral bodies vary considerably in their anterior projections, and frequently positioning the patient to decrease this encroachment actually decreases the operative area. The tori of the Eustachian tubes may project or actually be quite flat and defy even the most experienced digit to delineate the encroaching adenoid mass. In the average case the Rosenmueller fossa curette may satisfy the requirements in removing high lying adenoid tissue until a visual inspection by indirect mirror reveals the true state of affairs. The adenoid mass with simple hyperplasia tends to lie quite flat when the patient is in the recumbent Rose position. In some instances it can be noted to roll superiorly out of reach in the high vault and create some difficulty in removing with the conventional instruments. Anterior rhinoscopy at the time of surgery will in some cases reveal additional lymphoid tissue which is protected by the narrow aperture on either side of the posterior septum.

The conventional tongue blade type mouth gag does not permit as good visualization of the nasopharynx as the Jennings, which exerts no mechanical tension upon the soft palate when the manual palate retractors are used. The deficiency of this technique is the need of an assistant to retract the tongue and at the same time suction blood from the hypopharynx.

The adenotome or curette serves equally well for the main adenoid mass, although, unless the curette is sharpened frequently, it had better be discarded in favor of the La Force adenotome. The use of the curette is an acquired skill and unless properly executed tends to leave a strip of mucosa or even worse a lacteration of the aponeurosis or superior constrictor muscle requiring suturing.

After the removal of the midline adenoid mass and lateral extensions, an inspection of the operative area will invariably reveal

ragged remnants. Repeated curettage or efforts to remove these with the adenotome usually are unsuccessful and tend to damage the underlying aponeurosis and produce excessive scarring. The use of the Meltzer technique and Meltzer punch under direct vision will improve the cosmetic appearance and certainly leave one with a sense of satisfaction which cannot be obtained by the sole use of either the curette or the adenotome. During this phase it is very important that the pharyngeal reflexes be abolished, or the underlying fascia and muscle will be injured. This technique is quite definitely necessary when dealing with secondary operations where the amount of connective tissue in the adenoid remnants is marked. I have noted some types that could not be treated at all with the conventional instruments, and only a methodical and thorough removal under direct vision with a suitable punch or biting forceps accomplished a satisfactory operation.

One common evil of all surgeons is the indifferent anesthesia. The adenotonsillectomy requires the abolition of the pharyngeal reflexes. A few scant years ago the hurried procedure of guillotine tonsillectomy followed by very indifferent efforts in the adenoidectomy seemed to create a lasting impression on many anesthesiologists. While it may be true that a satisfactory tonsillectomy can be done in this fashion, the adenoid procedure cannot. When the desired cooperation cannot be obtained, the surgeon is tempted to hurry through a compromising position, and the result is an incomplete adenoidectomy. The endotracheal anesthesia does afford comfort in the child of 12 and up, but no one can deny that this additional encroachment imposes some penalty on the operator. The use of the nasal airway for endotracheal anesthesia in any adenotonsillectomy is obviously ill advised.

Modification of the Original Technique

Meyer performed the first adenoidectomy by using a small ring type curette introduced through each nasal cavity. While this approach is notably inadequate in present-day procedure, it did suggest an approach for the high adenoid remnant, the repaired cleft palate type, the incomplete cleft palate type, and the high palatal arch type, as well as the remnants in the allergic types. Meltzer suggests the use of a No. 1 ring punch for the high remnants that cannot be visualized with any type of retractor. Sheridan has described the use of the 2 cm. mirror in adenoidectomy. In my cases the types of remnants which can be removed by the intranasal approach constitute 25%. In visualizing the nasopharynx at the time of surgery the 23 mm. and 27 mm. laryngeal mirrors are used. The mirrors are warmed in a small metal cup of warm normal saline solution. Whenever possible the anesthetist is encouraged to refrain from suctioning through the nose to avoid early bleeding and obscure the first "panoramic" view of the nasopharynx. I have found that the Lothrop, Baron, or Jackson palate retractors are more satisfactory in that they provide more purchase in elevating the palate, while the Love is too shallow.

I prefer to do the adenoidectomy first for the following reasons: The palate is not weakened because the faucial pillars give additional support with the tonsils in situ while any instrument is being manipulated in the nasopharynx; blood from the tonsillectomy will accumulate in the nasopharynx despite suctioning, or bleeding will be started and impair the first indirect view through the mirrors; any slight oozing from the nasopharynx following adenoidectomy will usually be controlled by string sponges during the tonsillectomy, and if bleeding is present upon their removal direct inspection and control is necessary. While the sequence is optional, it is sometimes necessary to remove very pendulous hypertrophic type tonsils first to facilitate inspection of the nasopharynx. After the removal of the presenting adenoid mass and lateral segments an inspection of the nasopharynx with mirrors is attempted. Brisk bleeding for a few minutes is controlled by direct pressure with sponges with the palate retracted. Suc-

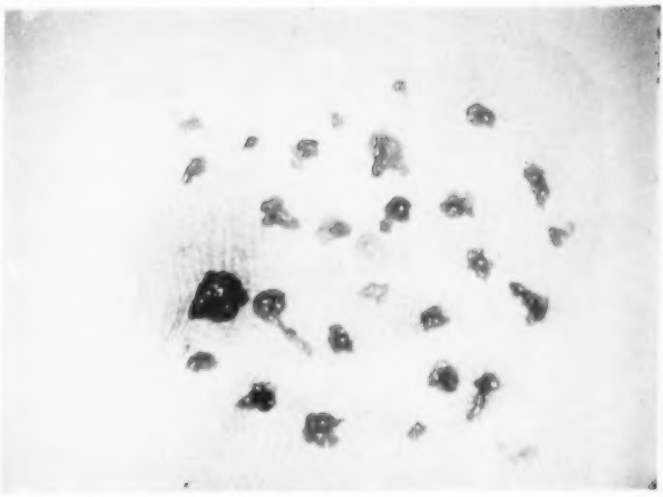

Fig. 1.—Adenoid remnants removed by the intransal method.

tion will usually help to evaluate the remaining requirements. When the remaining remnants are located high in the vault, the futility of any curette or adenotome can be noted by viewing the field with a mirror while the instrument is in position.

The use of an intranasal approach for this tissue seems reasonable. When either a Takahashi or a Wilde forceps is introduced through the nasal cavity, it can be observed to approach the high remnant with minimal manipulation, and under mirror vision precise removal can be accomplished. The palate is usually retracted by an assistant for this work, although a self-retaining palate retractor can be used. The introduction of the index finger is satisfactory in guiding the forceps to these remnants and protecting the Eustachian tube after initial inspection. The Takahashi forceps is preferred because of the blunt tip and narrow shaft. It can be introduced without trauma. In an occasional case a marked septal spur may interfere on that side, but considerable success can be obtained by utilizing a single nasal approach.

The forceps is always dipped in saline before use, and a water-soluble jelly has been used as a lubricant. The adenoid remnants in the vault are rarely fibrous, and the forceps described can remove this tissue satisfactorily because of the relatively sharp cutting edges. This technique requires multiple bites with the forceps and frequent inspection of the progress if not done with continuous mirror aid. Figure 1 is a photograph taken of the lymphoid tissue removed in an average case. The tissue submitted to the Pathology Department was reported as consisting of 1.20 gm. of "adenoidal tissue." The report was as follows: "The lymphoid tissue is covered by stratified squamous epithelium. There is intense acute and chronic inflammation of the epithelium. The lymphoid follicles are large and hyperplastic. Both acute and chronic inflammatory cells fill the sinusoids."

There has been no unusual bleeding from this procedure. A case of epistaxis did occur in one case, and upon closer inspection it was noted that the bleeding vessels indicated need of attention and had bled frequently prior to surgery.

Beatty [28] has described an operation to preserve the palate function following tonsillectomy. This is designed for the repaired cleft palate. No mention of adenoidectomy is made. The cases of repaired cleft palate in my series have required surgery because of recurrent otitis media and hearing loss. I have always left the midline mass intact in these cases and concentrated on the lateral

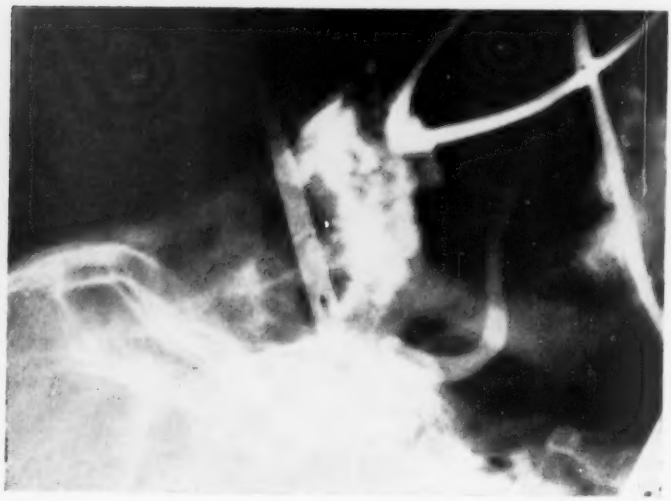

Fig. 2.—X-ray contrast of the forceps and curette in the narrow vault. The curette is exerting maximum tension on the soft palate.

and high adenoid tissue. The results with the intranasal approach have been gratifying in the end result, and the minimal tension on a taut palate may have reduced the occurrence of hyperrhinolalia. Undue and prolonged effort to remove high adenoid tissue by conventional instruments through the oropharynx may produce a rhinolalia aperta in the incomplete cleft palate and to a degree in the high palatal arch type.

The child with an indefinite allergy but with sufficient evidence of obstruction is certainly better off and more likely to have less otological involvement if a careful and painstaking adenoidectomy is performed prior to radiation or prolonged allergic control.

Figures 2, 3, and 4 are x-ray plates taken at the time of surgery to indicate the limitations of curette and adenotome in contrast with the intranasal forceps in the high adenoid type.

Summary

The first adenoidectomy was performed through the intranasal approach. Subse-

Fig. 3.—X-ray contrast of the adenotome and forceps in the same patient as in Figure 2.

Fig. 4.—X-ray contrast of the Rosenmueller curette and forceps in the same patient as in Figures 2 and 3.

quent studies by various authors through the years have revived this technique in certain types of residual adenoid tissue. A study of the various techniques for adenoidectomy and their application, together with their advantages and disadvantages, has been presented. The occurrence of otological complications following an inadequate adenoidectomy is a common fault of the casual procedure. The usual instruments employed in adenoidectomy are not always adequate for the particular lymphoid tissue to be removed. The feasibility of the intranasal approach, with suitable forceps, has been presented with evidence that it is an adequate method of removing the adenoid remnant or lymphoidal extensions in the postnasal space.

Conclusions

1. A careful examination of the patient before surgery will aid materially in planning the required effort to accomplish the desired result.

2. Visual examination by the use of palate retractors and indirect mirror technique is necessary to accomplish a satisfactory adenoidectomy.

3. A plane of anesthesia that will completely abolish the pharyngeal reflexes and maintain this level throughout the operation is imperative.

4. The use of suitable forceps introduced through the nasal passage is a valuable adjunct to the removal of adenoid remnants in specific types of palatal defects and the narrow high nasopharyngeal vault.

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A New Operation to Restore Hearing in Conductive Deafness of Chronic Suppurative Origin

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The purpose of this paper is to present a new operation, designed to be a standard operation, to eradicate infection and to restore hearing in deafness caused by chronic otitis media.

The operation is performed as a one-stage surgical procedure. For convenience of description, however, it will be divided into three stages: (1) the elimination of diseased tissue, (2) the plastic technique for rebuilding a middle-ear air space, and (3) the reestablishment of a new conductive mechanism. Each stage will be presented in turn; the technique will be illustrated, and the advantages will be described.

First Stage

To eliminate diseased tissue, in what may be called the curative part of the operation, I have used the radical mastoidectomy. The steps in the execution of this familiar procedure require no explanation except in relation to the preservation of the skin of the auditory canal. This skin is needed to carry out some of the plastic procedures in the second stage of the operation. Illustrations showing the performance of the radical mastoidectomy begin, therefore, after endaural incisions have been made, after the mastoid cavity has been exenterated and all diseased tissue has been removed, and at a point in the procedure where steps are taken to preserve this skin for future use.

In an operation to restore hearing in deafness caused by chronic otitis media I believe a radical mastoidectomy is a necessary first step for the following reasons:

1. The radical mastoidectomy assures maximum removal of diseased tissue. Furthermore, in chronic disease that is sufficiently established in the middle ear to cause deafness, more conservative measures will not enable the surgeon to remove the varying amounts of diseased bone, fibrous and polypoid granulation tissue, and cholesteatomatous material which may be encountered in the middle ear.

2. Plastic reconstruction will break down unless all diseased tissue is removed. This point is worth emphasizing. When an attempt is being made to cure disease and to rebuild a conducting mechanism in the same operation, a plastic technique is bound to fail if a proper foundation has not been established. This foundation, upon which all else rests, is the elimination of infection.

3. By widely exposing the middle ear we can properly evaluate the integrity of middle ear structures. The restoration of an air-containing, functional middle-ear cavity requires an open round window and an open Eustachian tube. Mucous membrane over the promontory, if not diseased, should be left as the best deterrent to fibrosis in the reconstructed middle-ear space.

4. By routinely performing an initial radical mastoidectomy we come to the same anatomical situation (Fig. 6) in every temporal bone. If we begin with this same uniform situation in every case, we can then

Received for publication April 17, 1957.

Read at the Combined Meeting of the Section on Otolaryngology, New York Academy of Medicine, with the Section on Otolaryngology, College of Physicians of Philadelphia, New York, March 20, 1957.

From the Department of Otolaryngology, Lenox Hill Hospital, and the New York Eye and Ear Infirmary. The animal surgery was carried out in the Otolaryngological Research Laboratory, New York University-Bellevue Medical Center. This work aided by the E. E. Foreman Fund.

Fig. 1.—The bony posterior canal wall is taken down to expose the skin of the external auditory canal.

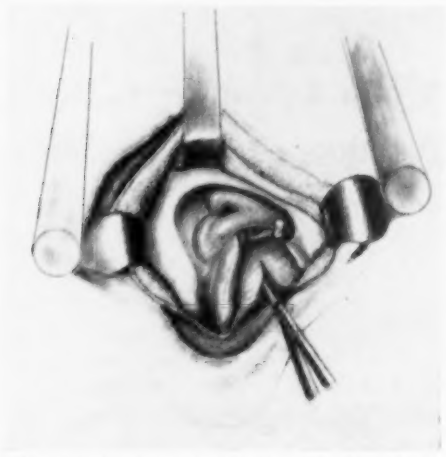
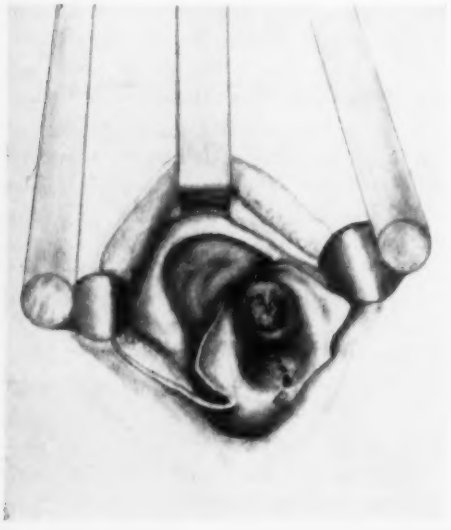


Fig. 2.—A scissors incision is made through the skin of the posterior canal wall all the way to the drum.

follow with a standard reconstructive plastic procedure. This is not possible if varying parts of the conducting mechanism are left, necessitating numerous adjustments of the operative technique to fit the pathological findings in each individual case.

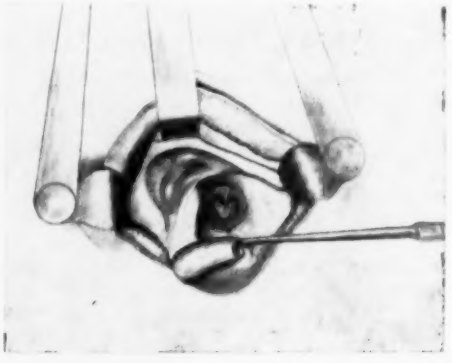
Fig. 3.—The incision edges are retracted, exposing the lumen of the external auditory canal. A circumferential incision is made just external to the annular ligament. A perpendicular incision is made from the drum outward, bisecting the canal skin into two parts, each with a pedicle attachment.



Second Stage

The second part of the operation deals with the problem of the plastic reconstruction of an air-containing middle-ear cavity. Although the principles of functional surgery of the middle ear in chronic otitis media have been understood for a long time, the great stumbling block to the practical application of these principles has been the difficulties of developing a surgical technique for creating a permanent middle-ear air space. These difficulties begin with the fact that there is not enough tissue in the vicinity of the middle ear to carry out any extended

Fig. 4.—The skin forming the inferior pedicle flap is elevated. The skin of the auditory canal is elevated as two separate pedicle flaps to prevent tearing.



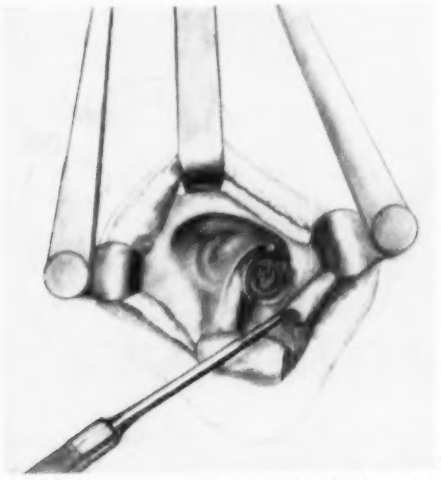


Fig. 5.—The superior pedicle flap is elevated.

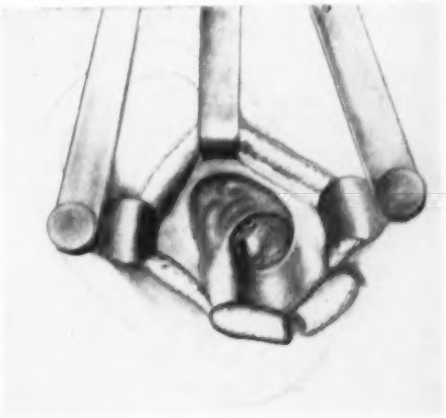
plastic reconstruction. If to make closure of an air-containing space simpler we try to preserve infected structures, the possibility of curing the disease diminishes. If we remove the original structures of the conducting mechanism in the interests of eradicating disease, the plastic reconstruction becomes decidedly more difficult. The problem then becomes one of swinging a free skin graft across a large air space without adequate support and maintaining the plastic reconstruction with a precarious blood supply. These difficulties are illustrated by some of my own attempts to create a middle-ear air space.

My first efforts to restore hearing in chronic otitis media were supported and encouraged by Dr. Julius Lempert, at the Lempert Institute of Otology. This was in 1949. At that time we were able to close total perforations of the drum in dry middle ears, in 5 cases in a total of 10 cases tried, by dropping a pedicle flap of skin from the anterior wall of the auditory canal. By combining the new air space with the fenestration principle we obtained good, practical hearing. The technique, however, involved diverting epithelium into the middle ear and, because of this, all the new drums were destroyed in three to four months as a result of cholesteatomatous activity. Physiologically the procedure worked, but the plastic reconstruction did not remain permanent. Furthermore, the technique was limited to dry ears.

Following this, from time to time, in doing routine radical mastoidectomies, I attempted to form a middle-ear space by bringing in split-thickness skin grafts from the thigh to bridge the middle-ear cavity. In almost every case, regardless of how carefully the graft was packed into place, fibrosis occurred in the middle ear, pulling the skin onto the promontory and obliterating the space.

I considered several ideas for using prosthetic devices to maintain the middle-ear space, one of which was to fill the middle-ear cavity with paraffin before covering with a skin graft from the thigh. In a second-stage procedure, after mucous membrane had grown in from the Eustachian orifice to line the middle-ear cavity, the graft might then be elevated from the posterior end to expose the horizontal semicircular canal and the middle-ear cavity. The paraffin would then be removed, the horizontal semicircular canal fenestrated, and the graft replaced over the fenestra. This method, however, would have the disadvantages of using prosthetic material, poor initial drainage from the middle-ear cavity, precarious blood supply to the graft, and an uncertain healing period between the first and second stages.

Fig. 6.—The radical mastoidectomy is then completed.



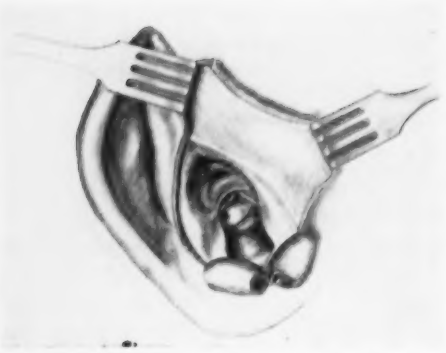


Fig. 7.—Exposure of the temporal muscle is gained at operation by extending the superior endaural incision upward for a short distance (closed by suture at the completion of the operation) and by separating the loosely attached overlying scalp from the temporal fascia.

I thought it might be a better idea to leave a bridge of bone at the notch of Rivinus as a mechanical aid to prevent the flexible skin graft from falling into the middle ear and, at the same time, to use the periosteum-lined skin of the auditory canal as a skin graft, which I thought might reduce the formation of fibrosis in the closed middle-ear space. In 1950, in a case with total absence of the drum and a dry middle ear, I removed all of the auditory canal skin in one large piece. This graft was large enough so that I was able to lay it against the anterior bony auditory canal wall, bridge it across the middle-ear space, have it supported by a thin bridge of bone at the notch of Rivinus, and then have it reach the horizontal semicircular canal to cover a newly made fenestra. The hearing gain in this case, which averaged 33 db. in the three speech frequencies, has been maintained to the present time, more than six years later. In this case a permanent middle-ear air space was successfully maintained, and the improvement of hearing based on the fenestration principle was successful. However, to obtain all of the auditory canal skin in one large piece without tearing it in its thinnest portion was a difficult task. Also, the leaving of a bridge of bone was a serious limitation in the technique because it prevented a thorough removal of diseased tissue in the middle ear.

Fig. 8.—The temporal muscle pedicle flap is cut as indicated. It maintains an adequate blood supply from the posterior deep temporal artery.

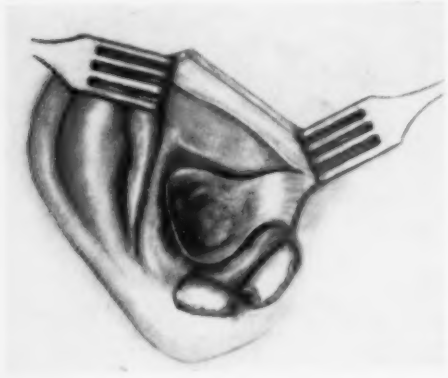


Fig. 9.—The pedicle flap of the temporal muscle is brought down into the radical cavity to bridge over the middle-ear space and to cover the horizontal semicircular canal and the floor of the mastoid.

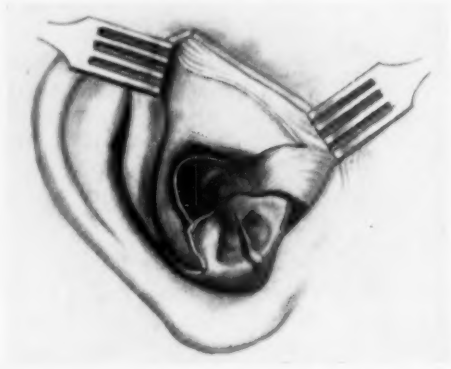


Fig. 10.—The two pedicle skin flaps, previously preserved from the skin of the auditory canal, are placed over the muscle flap.

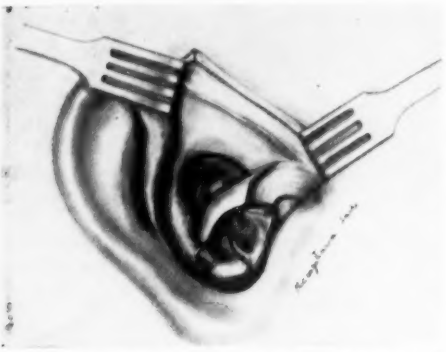


Fig. 11.—The temporal muscle flap is elevated, and a fenestra is made in the horizontal semicircular canal.

These experiences convinced me more and more that in order to provide a standard technique for creating a middle-ear air space the following requirements must be satisfied:

1. All of the diseased tissue must first be removed.

2. Enough tissue must be brought into the middle-ear region to carry out total reconstructive procedures.

3. This tissue must have adequate blood supply.

After a time I recognized the possibility of using the temporal muscle to cover the middle-ear space. The thin temporal muscle, covered superficially by a thick, strong temporal fascia and underneath by a periosteal membrane, offers an adequate bank of tissues from which we may borrow, ideally situated and suited for plastic reconstruction of the middle ear.

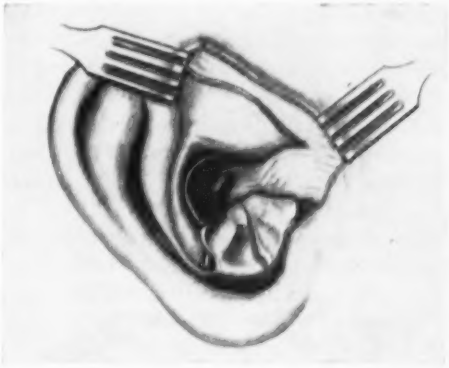
This technique for reconstruction of a middle-ear air space offers several very distinct advantages:

1. The pedicle flap from the temporal muscle is thick enough so that in bridging the middle-ear space it does not collapse into the middle-ear cavity as a split- or full-thickness skin graft does. Hence there is no need of measures necessary to support a skin graft, such as leaving remnants of the drum, or leaving a bony bridge at the notch of Rivinus, or packing the middle ear with fibrin foam.

2. All the tissue components entering into the formation of the middle-ear covering are pedicle flaps with pedicle blood supply. Furthermore, the pedicle skin flaps overlie the well-nourished muscle flap instead of overlying an air space. These features insure good blood supply in the plastic reconstruction. No free skin grafts from a donor site are required, involving the uncertainties of a "take" because of precarious blood supply.

3. Covering the middle ear with the relatively thick temporal muscle affords greater protection to the round window, resulting in better hearing on the fenestration principle because of the increased sound pressure differential between the two windows. It has been said that after a fenestration operation the best hearing occurs when the fenestra is as open as possible and the round window as blocked as possible. Skoog and Nilsson, Rytzner, Shambaugh, Lempert, and others have demonstrated this clinically by placing an ointment base which can absorb three times its own weight of water (Aquaphor) in front of the drum in postoperative fenestration cases to obtain better phase differentiation and thus better hearing. I think we get the same blocking of the round window by virtue of the increased thickness of the temporal muscle over that of the normal tympanic membrane.

Fig. 12.—The temporal muscle flap is replaced to cover the fenestra. A small polyethylene tube is left as a drain from the middle-ear cavity.



Third Stage

The third stage deals with the problem of reestablishing a conductive mechanism. With a newly created middle-ear space this can be done on the basis of the fenestration principle.

I have used the fenestration procedure to reestablish a conductive system because it is the most reliable and predictable method that we have today for restoring hearing in conductive deafness. This is so because in this procedure there is a by-passing of fixation in the middle ear, whether the fixation is due to otosclerosis or to cicatricial tissue. In a reconstructed middle-ear space, whether disease has healed spontaneously or has been removed by surgery, scar tissue is inevitably formed. Therefore, a system for mobilizing inner ear fluids that is not influenced by pathological conditions at the oval window will prove to be more reliable in obtaining permanent hearing.

Animal Surgery

To study the histological effects of the operation as outlined above, I carried out the reconstruction of a middle-ear air space, after having performed a radical mastoidectomy, in the rhesus monkey (Macaca mulatta). Approach to the mastoid was through a postauricular incision. In the performance of the radical mastoidectomy two pedicle flaps were fashioned from the auditory canal skin, as previously described. The mucous membrane of the middle ear was not disturbed. A pedicle flap from the temporal muscle was cut and brought down into the cavity to cover the middle-ear space and the horizontal semicircular canal. The previously elevated skin flaps were placed over the muscle flap. The mastoid cavity was filled with paraffin, and the postauricular incision was closed primarily. The animal was allowed to live for three months. The temporal bone was fixed in Heidenhain-Susa solution, and a hematoxylin-and-eosin stain was used. Section of the temporal bone was in a horizontal plane through the long axis of the external auditory canal.

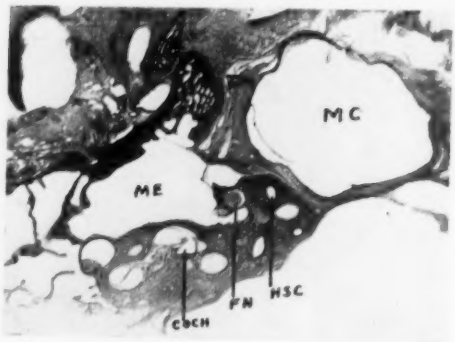


Fig. 13.—ME, middle-ear space; MC, mastoid cavity; TM, pedicle flap from the temporal muscle; HSC, horizontal semicircular canal; FN, facial nerve; COCH, cochlea. Good blood supply to the plastic reconstruction is indicated by the normal appearance of the temporal muscle structure, showing no evidence of degeneration, and by the complete epithelization of the mastoid cavity after three months. Note how well the thicker anterior portion of the temporal muscle pedicle flap bridges the middle-ear space. An idea of the protection that this portion of the muscle provides to the round window is also obtained. The thinner posterior portion of the temporal muscle flap furnishes an appropriate thickness over the horizontal semicircular canal.

Application in the Human

The reliability and predictability of this standard operation is indicated by its application in varying pathological situations in the following cases of bilateral chronic otitis media.

Case 1.—A 30-year-old woman gave a long history of bilateral chronic otitis media dating back to the age of 4. At the age of 11 she had a left postauricular simple mastoidectomy, with continued postoperative suppuration; at the age of 18 she had a postauricular modified radical mastoidectomy on the same ear, with continued postoperative suppuration, and at the age of 24, three years before I first saw her, she had an endaural radical mastoidectomy on the same ear, with continued postoperative suppuration. The hearing level in the preoperative audiogram in the three speech frequencies averaged 52 db. in the right ear and 55 db. in the left ear.

Efforts to get the left radical cavity dry were unsuccessful. This was due to the fact that the Eustachian tube orifice had not been sealed off at the time of the radical mastoidectomy and an area of mucous membrane had grown posteriorly over the promontory from the Eustachian orifice. These conditions in the middle ear—an open Eustachian tube, a suitable mucous membrane over the promontory, and an unobstructed round win-

dow—not usually found in the postoperative radical mastoidectomy, indicated the possibility of reconstructing an air-filled middle-ear space in this particular case. The cavity was actively suppurating, and for a few days before operation I kept it filled with antibiotic ointment.

On Nov. 11, 1956, the operation as previously described was performed as a one-stage surgical procedure, with the following added explanation: Endaural incisions were made to widen the previously made endaural opening. The pedicle flaps usually fashioned from all the auditory canal skin were formed from the skin covering the anterior two-thirds of the auditory canal region. The mastoid region of the cavity was revised to remove infected granulations in unepithelized areas. The mucous membrane over the promontory was not disturbed. The temporal muscle was brought down into the cavity to create a middle-ear space, and a fenestra was made in the horizontal semicircular canal by the dry cupola technique. A small polyethylene tube drain was left in the middle-ear space for a period of 10 days. The patient received higher than average doses of penicillin and average doses of sulfadiazine for a period of 10 days. The hearing gain is shown in the accompanying audiogram (Fig. 14).

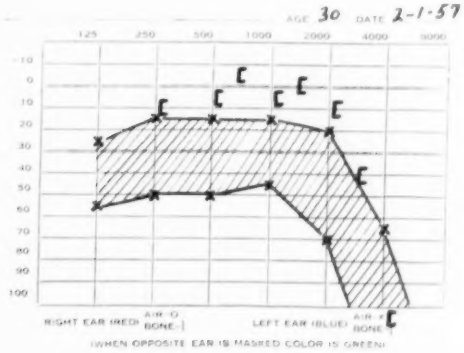
CASE 2.—A 39-year-old man gave a history of bilateral chronic otitis media with almost continuous bilateral chronic discharge since early childhood. A simple mastoidectomy was performed on the left ear at age of 3. Loss of hearing had been progressive since early childhood. The left ear had always been the better-hearing ear. The patient wore a hearing aid.

Large kidney-shaped perforations existed in both tympanic membranes, with suppuration being present in both middle ears. The right ear, the poorer-hearing ear, was selected for operation, and for a few days preoperatively it was treated with local antibiotic therapy. The operative findings were as follows: The mastoid contained necrotic bone and infected granulation tissue. The long process of the malleus, the incus, and the crura of the stapes had been eroded away by disease. An extensive cholesteatomatous matrix extended from the anterior remnant of the drum onto the promontory and covered the posterior two-thirds of the inner wall of the middle ear, the antrum, the horizontal semicircular canal, and the floor of the mastoid cavity. An air pocket existed in the vicinity of the Eustachian tube orifice, and the anterior third of the inner wall of the middle ear within this pocket was covered with normal mucous membrane. When the cholesteatomatous matrix was carefully removed in its entirety a thin, atrophic subepithelial layer of tissue resembling mucous membrane remained over the posterior two-thirds of the inner wall of the middle ear.

The operation as previously described was performed as a one-stage surgical procedure. The patient received tetracycline (Achromycin) and a preparation containing sulfamethoxypyridazine (Kynex) for a period of 10 days postoperatively. A polyethylene tube drain was left in the middle ear for a period of 10 days. The hearing gain is shown in the accompanying audiogram (Fig. 15).

CASE 3.—A 16-year-old girl had had bilateral chronic otitis media and discharging ears since early childhood. A simple mastoidectomy was performed on the right ear at the age of 2. Hearing had become progressively impaired since childhood. The patient had received lip-reading training twice a week for two years in the New York Public School system. She attended high school with the help of a hearing aid.

Large kidney-shaped perforations existed in both tympanic membranes, with a fetid discharge in both middle ears. The mucous membrane over the promontory was edematous and irregular in the right ear. The mucous membrane over the promontory was smooth in the left ear.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RIGHT EAR (RED) AIR BONE
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Figure 14 (Case 1)

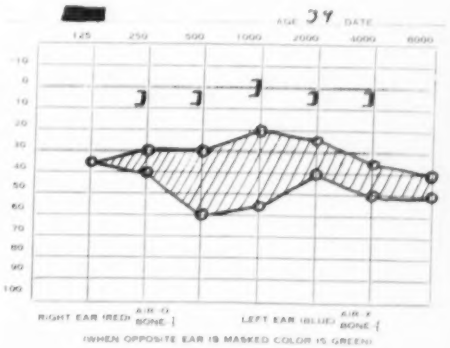
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Figure 15 (Case 2)

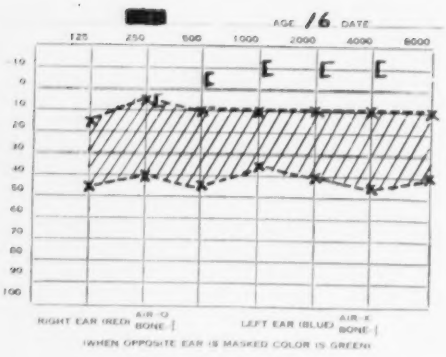

Figure 16 (Case 3)

The left ear was selected for operation because of the more favorable appearance of the mucous membrane over the promontory. For a few days preoperatively this ear was treated with local antibiotic therapy. Operative findings were as follows: Infected granulations and necrotic bone were found in the mastoid. The long process of the malleus and a portion of the incus were destroyed by disease. The stapes was intact. No cholesteatoma was present. A smooth mucous membrane was present over the promontory. The Eustachian tube was open. The round window was clear.

The operation as previously described was performed as a one-stage surgical procedure. The patient received tetracycline and Kynex for a period of 10 days postoperatively, and a polyethylene tube drain was left in the middle ear for a period of 10 days. The hearing result is shown in Figure 16.

535 Park Ave. (21).

Dr. Ernest G. Wever and Dr. Georg von Békèsy gave helpful criticism in the preparation of this paper, and Dr. Sidney Rappaport photographed the original cadaver dissections from which the illustrations were drawn by Mrs. M. Sachs.

Contribution to Etiopathogenesis of Pharyngitis Sicca Chronica

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During the last few years we have had the opportunity to inspect and follow a certain but not small number of pharyngitis sicca cases, which, according to their etiopathogenesis and their clinical picture, belonged to a special group. In these cases we could not find an explanation of the pharyngitis in known causes, as in over 100 cases we could not find a local injury on the mucous membrane to account for the ozena, or any change in the adjacent regions of the nose (disease of the paranasal sinuses, tonsillitis, dental caries, disease of the larynx or the trachea, or signs of Thornwaldt's disease). Our cases did not give evidence of any endogenous or exogenous intoxication. We could not detect any sign of avitaminosis or hypovitaminosis, especially with regard to the described dryness of the throat, particularly of Sjögren's disease due to lack of vitamins A and B. Tests for allergy did not give positive results. The extent of the role of endocrine dysfunction in the pharyngitis sicca manifestations is defined, in our opinion, by the degree of disturbance of the equilibrium of the endocrinovegetative relation. The complicated relation of the autonomic nervous system and the endocrine system, as well as the question of supremacy of the one over the other, makes it difficult to give an explanation even if the supremacy of the autonomic nervous system over the endocrine system through higher vegetative centers is more probable.

The majority of our patients who complained of disagreeable dryness in the throat also complained of various pains in different parts of the neck and, usually, of the almost typical headaches. The number of those who complained of continuous headaches and in whom we diagnosed pharyngitis sicca after a thorough examination was not small. The latter group induced us to start neurological investigations.

Inspection of the pharynx showed that the mucous membrane was more or less covered by thick and sticky mucus, as if varnished. The secretion was at times viscous and sometimes mucopurulent.

The mucous membrane of the pharynx is more or less dry. In the epipharynx this dryness is of a higher degree. At the moment of contraction of the constrictor muscles the mucous membrane which is inflamed becomes distinctly wrinkled, and its color is like that of boiled ham. In cases of long-lasting illness the condition of the mucous membrane changes. It takes on a structure as if flattened; the individual lymph nodes disappear, and the blood vessels become thinner, slightly filled. The macroscopic picture looks like atrophy of the mucous membrane. The power of resistance of the atrophic mucous membrane is essentially diminished.

In all the pharyngitis sicca cases in which it was impossible to find the cause among the presently known etiopathogenic factors, the neurological finding was always positive, i. e., the new extrapyramidal syndrome (Vujic and Ornsteen). This syndrome points to lesions of subcortical structures. But regarding the whole clinical picture in our cases, there is probably a lesion of the diencephalon in the first place. The experimental work of Hess, the observations of Vujic and of others, and ours also, indicate that the vegetative symptoms are of-

Accepted for publication May 31, 1957.

ten connected with functions of the subcortical motor system.

The whole clinical picture in our cases is that of the symptomatology of neurovegetative asthenia. Headache is the most prominent among the subjective complaints; there is also a sensation of dryness and itching in the throat. Headache is generally diffuse, less frequently unilateral, mostly in the occiput and in the sinews of the neck. The patients feel pains in the entire head as if a cover were tightly pressed over the head. Various cardiovascular symptoms, a sense of suffocation, disturbance of sleep, shivering, sweating either over the whole body or limited to certain parts of it were found rather often, which speaks in favor of focal lesions. Disturbances, variously manifested, of the vegetative and endocrine systems are frequent. Characteristic is the intolerance to the suns rays and heat, rarely cold and alcohol.

In most of our cases we found arterial hypotension. Among the laboratory findings we most frequently found hyperlymphocytosis (about 90% of the cases), negative values of the basal metabolism rate (about 80% of the cases), and a slight increase in the eosinophil count. Almost all cases gave lower numerical values for the clot retraction time.

Seasonal fluctuations in the intensity of the subjective complaints and manifestations are characteristic. During the hot summer days the subjective complaints reach their culmination, accompanied by maximum manifestations of the entire clinical symptomatology. More seldom does cold have this effect. Low altitudes have a deleterious effect on subjective complaints and the intensity of the manifestations of clinical symptomatology.

Psychical insults of various kinds, especially in the affective sphere, cause a change for the worse, either subjectively or objectively, most probably on a hypothalamic basis.

Besides Vujic, Heinsen, and other authors, P. Blanchet says that in spite of visible clinical heterogeneousness, the manifold symptoms of pathogenetic cohesion without doubt have a diencephalic origin.

It is significant also that P. Blanchet has noticed among the neurovegetative symptoms "pharyngeal causalgia" with occipitocervical pains. He even mentions pharyngeal dryness," which reminds him of a type more or like the appearance of "syndrome of Sjögren, the reverse of the syndrome of Gougerot."

As vegetative stigmatism in the sense of vagotony is dominant in our cases, it is probable that the dryness of the throat is a result of the intermediofacial nerve bringing parasympathetic fibers to the mucous glands of the pharynx.

The increase possibility of injuring the diencephalon, especially the hypothalamus, by noxae of various origins is well known. We might say that there is hardly any noxa to which the diencephalon does not react, either primarily or secondarily during the illness.

The increased possibility of injuring the different natures, on passing over the hematoencephalic barrier, first reach that part of the brain. In that increased vulnerability of the diencephalon to noxae of various kinds we must trace the cause, explaining why in individual cases we can answer that very important question: which noxa is involved in an individual pharyngitis sicca case?

The history in most of our cases made us believe that we were dealing with a case of earlier or later infection. We also had opportunity to see cases of many different noxae which manifested pharyngitis sicca by lesions of higher vegetative centers in the diencephalon, with the rest of the clinical symptomatology and the subjective complaints described above.

Report of Cases

Case 1.—A woman aged 65 years. Family history not important; personal history: nothing pertinent in former illnesses. The present illness started one year ago, a few weeks after an attack of grippe. It started with headache in the form of

tenseness in the neck and pressure throughout the head. At about the same time, she felt dryness in her throat, and with continuous headache she had a feeling as if she had a "wasp" in her throat. She became irritable, slept poorly, was easily enraged, and cried easily. She often had a feeling of drunkenness, especially when in the sun.

Ears and nose: without change. Throat: dry mucous membrane of the pharynx without lymph nodes, looks varnished; sticky mucus. Neurological finding: on the left is present Ornsteen's second sign, bilateral radial deviation fists; on the left reduced automatic movements of hand, bilateral supercilia sign. The sign of Negro on the neck. Further somatic neurologic findings without marked deviations. Affectively labile. Pulse rate: 68. BP 120/80 mm/Hg. BSR 10/28. Wassermann reaction: negative. Differential white cell count: 30% lymphocytes; other values within physiological limits.

Case 2.—During his entire life the patient had often had various undefined febrile states. In 1949 operated on because of deviation of the nasal septum. In the last four years continuous headache, severer during summer heat. Headache is diffuse in the occiput and the sinews of the neck, often feeling like a cover over the skull which presses and tightens. There is a feeling of tightness around the heart; he shivers over the whole body, tires easily, and the palms of the hands are sweaty. He suffers from insomnia or constant sleep. He notices impaired power of concentration. All this is followed by dryness in the throat, which occurs simultaneously with the other subjective complaints. Paranasal sinuses without pathological findings. Breathing through nose normal. Teeth in good condition. Throat: slightly red, dry, the mucous membrane in some places covered with mucous secretion.

Neurological: Pronatory posture of fists, automatic movements of the right hand have almost disappeared, Ornsteen's second sign bilaterally positive, the sign of supercilia present. Negro's sign present on the neck and the right arm. Other somatic-neurologic findings without deviations. Psychically: Basal metabolism rate: 6% value. Differential white cell count: within physiologic limits, only 5% eosinophils and 34% lymphocytes. Clot retraction starts promptly and shows inferior numerical values.

Case 3.—Patient 22 years old. Often had various febrile illnesses. Especially frequent angina. During the past year complained of dry throat and thick sputum, which can be removed only by attacks of coughing. In the last three months continuous headache with many complaints of neurasthenic type. Objectively: Mucous membrane of oropharynx dry and diffusely covered with mucopurulent secretion of sticky and thick consistence. Structure and appearance of the mucous membrane differs from normal, as if not sufficiently supplied with blood and lymph nodes; looks atrophic. Ear and paranasal cavity without change. Neurological findings: No somatic neurological deviations, except neurovegetative asthenia with new extrapyramidal syndrome. BP 100/70 mm/Hg. Basal metabolism rate: —5%. In the differential white cell count besides 34% lymphocytes there are also 4% eosinophils without any pathological values. Clot retraction starts a little later than normal and shows lower numerical values.

Case 4.—Patient 19 years old, was ill two years ago with high temperature and "troubled conscience." Typhoid suspected; he was in the infectious department, but all typhoid findings were negative. During the past year constant fatigue and sleepiness. Easily loses temper and weeps. Feels dryness and itching in the throat. Ear, nose, and throat: normal, except dryness of the mucous membrane of the throat, which is covered with sticky, glassy secretion. Neurologically: distinct neurovegetative asthenia with new extrapyramidal syndrome: Vujić-Ornsteen sign, without any somatic neurologic deviations. Psychically: affective lability with hypophrenic syndrome and lack of spontaneity. BP: 95/70. Basal metabolic rate: —25%. Cerebrospinal fluid normal. Differential white cell count within physiological limits. Lymphocytes 38%; eosinophiles 4%. Sedimentation rate: 2/6. Clot retraction shows reduced values.

Case 5.—Patient 32 years old. Had almost all children's and infectious diseases, frequent grippe. In the last two or three years constantly tired, no day without headache and tightness in the sinews of the neck. In summer and in the sun headache is unbearable, with itching in the throat. Ear, nose, and throat: findings normal, except atrophic dry mucous membrane of the pharynx, partly covered with sticky mucus, with dry, varnished-appearing surface. Neurologically: Maximum marked new extrapyramidal syndrome. BP: 90/70. Basal metabolic rate: —28%. Affectively labile. Lymphocytes 40%; eosinophiles 4%. Clot retraction shows reduced values.

Conclusions

In our cases with objective local findings indicating pharyngitis sicca chronica, with a subjective sensation of dryness in the throat, there are numerous subjective complaints and various objective manifestations which point to vegetative or vegetative-endocrine disturbances. In all our pharyngitis sicca cases we found a more or less distinct symptomatology of focal character, which

indicates a lesion of the extrapyramidal system. In the clinical picture of our cases, manifestations of lesions of higher vegetative centers in the diencephalon are predominant. These facts firmly support our opinion that in the etiopathogenesis of pharyngitis sicca the lesions of the diencephalon hold a special place.

Bulevar Marsala Tita 10/11.

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Vascular Labyrinthine Syndromes in the Light of a New Technique

Labyrinthine Iontophoresis

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In August, 1955, we published the first results obtained in the treatment of hydrops and other functional vascular conditions, with a new technique elaborated by us: iontophoresis of the inner ear using intratympanic medicinal injections.[1] We had previously carried out iontophoresis, using the medicinal substance in the canal, without obtaining satisfactory results; this work was done in collaboration with Dr. Alberto Martinez Visca, who suggested the method to us.[2] To this idea of Dr. Martinez Visca we added the intratympanic technique of medicinal injection which by facilitating ionic molecular continuity favors labyrinthine iontophoresis and has given us our first therapeutic successes.

During the nine months that we have studied and applied this new method, we have done 69 iontophoreses in 38 patients with syndromes of organic and functional vascular processes.

For the time being, our experience is based on the use of a powerful vasodilator of the arteries and the arterioles, tolazoline, the hydrochloride of 2-benzyl-2-imidazoline (Priscoline) in combination with hyaluronidase (Wydase). The reason for the use of these medicaments is that, like the majority of otologists, we consider that in many of these conditions, especially in hydrops, there is a vasospasm of the trunk or branches of the internal auditory artery; this vasospasm by anoxia causes greater permeability in the capillary wall and creates a true local circulatory insufficiency. At first sight it would seem paradoxical to use tolazoline when it is presumed that there is greater hydrostatic and colloidosmotic pressure in the interstitial liquid, but in reality what we are combating is the local circulatory insufficiency, and by improving it we facilitate nutrition, trophism, and all the biochemical and enzymatic labyrinthine processes. We add the hialuronidase to facilitate the diffusion of tolazoline, improve the blood stagnation ("blood sludge," Knisely[3]), as well as the nutrition, influence the endolymph and the hydrops (high content of "hyaluronic" acid in the endolymph, Vilstrup[4]), and finally to facilitate the reabsorption of the liquid injected in the tympanic cavity.

The results have been very satisfactory and interesting as regards the physiopathological study of these processes, the diagnostic considerations, and the therapeutic possibilities presented, promising even more in the future for these troublesome and frequent labyrinthopathies that have always led to repeated failures in the daily practice of all the specialists.

We believe there is open a wide field for experimental and clinical study, and we already have begun the study of new medicaments, such as iodine and iodides, nitrates, etc.

Technique of Iontophoresis of the Inner Ear

We anesthetize the tympanum with the solution proposed by Trowbridge[5] for his

Accepted for publication April 18, 1956.

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Presented at the Fifth Pan-American Congress of Otorhinolaryngology, and Broncho-Esophagology, San Juan, Puerto Rico, April, 1956.

treatment of tinnitus (oil of aniline 90 parts chemically pure, 10 parts of cocaine hydrochloride U. S. P.) by means of a small cotton-wool ball left 10 minutes against the ear drum with the patient lying down. While the anesthesia is being carried out, we prepare the intratympanic injection, using all sterilized material: a small syringe with a special needle made of a intramuscular needle with a very fine point (intradermal needle). Removing the cotton wool, we then inject in the posterioinferior tympanic quadrant 0.8 cc. of the tolazoline solution intramuscularly (10 mg./cubic centimeter) and 0.2 of the fresh solution of hyaluronidase of 150 units, TR. The patient must be lying down, and the injection is given slowly so as not to produce vertigo due to the cold irrigation of the promontory and to avoid rapid intratympanic tension, which, when the injection has been given and the needle taken out always produces a murmur with reflux of the excess air and liquid. In spite of the patient's being prone with his face to one side, it frequently happens that the patient feels some of the liquid that runs down his throat through the tube. We then insert a glass speculum, specially made, inside which is a long, thin cotton-wool wick of about 3 or 4 mm. and about 10 cm. in length, well soaked in a small glass sterile vessel with about 6 drops of the solution of 10% tolazoline (for iontophoresis) plus the remaining tolazoline solution left in the ampule previously used (in the intratympanic).

The soaked wick is carefully inserted through the glass speculum, filling all the external auditory canal and coming out through the glass speculum. We then place

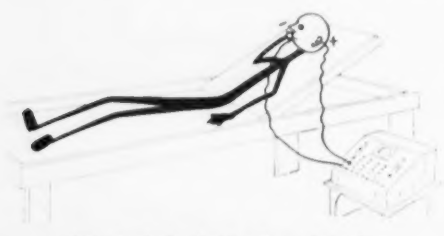

Fig. 1.—Labyrinthine iontophoresis.

Fig. 2.—Preparation for labyrinthine iontophoresis.

the insulated copper wire (with plastic covering), with the active pole, in this case the positive pole, between the dampened wick and the wall of the glass funnel, holding it in position with tape. The indifferent negative pole, which closes the circuit and orientates the electrical field is a zinc plate well covered by cotton wool soaked in water, placed under the opposite ear and held in place by the patient's hand. We pass the galvanic current by slowly increasing the amperage through a very soft continuous attenuator, without painful variations, and arrive at 1 ma., continuing the application for half an hour (it is convenient to use a special alarm clock). We have tried the 2 ma. doses for 15 minutes, but the majority of the patients find it painful and sometimes intolerable because of the vertigo that is caused even when the amperage is increased and decreased slowly at the beginning and the end of the application. Nevertheless, there are some persons that tolerate the maximum dosage, which shortens the time of the iontophoresis. Both doses are 30 ma. per minute. We have tried in some cases giving tolazoline orally, but it is not well tolerated by many patients. Dr. Alberto Martinez Visca has used the drop-by-drop intravenous infusion of tolazoline diluted in serum, together with iontophoresis, in the treatment of diabetic arteritis of the lower limbs.[6] We plan on using this method for the cases that do not improve with simple iontophoresis. The

idea is to contribute through the blood to the fixation of the circulating tolazoline that passes through the electric field of the iontophoresis. We generally perform iontophoresis weekly until we get an improvement, or until we prove the inefficacy of its repetition on the audiogram, shown by the hypoacusia, by the degree of tinnitus, and by the history of vertiginous conditions, if any. In some Ménière patients, after relative improvement has been reached, we have repeated the iontophoresis monthly without any inconvenience up to 11 applications, which is the maximum reached with an individual patient. In this manner the vertigo in crisis decreases and disappears, as also the permanent state of dizziness, and the tinnitus decreases or disappears.

Lately, we have supplemented the iontophoresis, in the intervals between treatments, with vasodilators given orally. We have asked the distinguished cardiologist Dr. Alberto Amargós[7] about the vasodilators most effective in controlling the crisis of angina pectoris orally, medicaments that have shown their efficacy in clinical practice. Dr. Amargós reminded us that there are vasodilators that do not work on cerebral territory. Brobeil expresses himself in the same terms. Dr. Amargós is partial to nitrates, especially to the hexanitrate of mannitol, a vasodilating substance which, having prolonged action, is superior to the nitrites in general and to erythrityl tetranitrate, and which, besides, has the advantage that the return to normal takes place gradually. In cases of urgency glyceryl trinitrate (nitroglycerin, trinitrin) has a more rapid vasodilatory action. According to Brobeil,[8] the glyceryl trinitrate has a stronger and more lasting action than amyl nitrite. Also, according to Brobeil, we have, besides the nitrites, cerebral vasodilators, such as papaverine, histamine, Lacarnol (a nucleoside preparation), antipyrine, and pilocarpine. (Acetylcholine has little effect on the brain—Brobeil.)

We have been using mannitol hexanitrate (dosage, 0.032 gm. four times a day), with phenobarbital if there is nervousness or a psychic component that requires it, besides phosphate of codeine, papaverine, or of the various other preparations. We believe they have a more favorable action on Ménière's disease and in the processes of labyrinthine arteriosclerosis. In some patients we have seen the improvement of a sudden crisis of tinnitus, with use of glyceryl trinitrate.

In the vertiginous crisis of Ménière's disease we use chlorpromazine (Largactil) (2-chloro-10-[3-diamethyllaminopropyl]phenothiazine), a sedative of the autonomous nervous system—sympathetic and parasympathetic—and of the central nervous system, a hypnotic, hypothermic, antiemetic, etc. According to studies made by Prof. J. M. Tato,[9] it brings about the disappearance of the nystagmus provoked by ice water in the ear. Generally, a dosage of 2 cc. intramuscularly every 8 or 12 hours controls vertigo and vomiting. If it is necessary to overcome a slight sensation of dizziness we give it orally 25 mg. every 12 hours or more, with or without dimenhydrinate (Dramamine). The chlorpromazine works favorably on the dystonias of the autonomous nervous system and especially on the dystonias of the female or male climacteric, working definitely against the vasospasm which is a consequence of this dystonia of the nervous system.

Results of Iontophoresis

In the nine months that we have studied and applied iontophoresis we have performed 69 iontophoreses in a total of 38 patients with various syndromes and affections of a functional or organic type. But now, as we have already said, we are limiting ourselves to studying the vascular spasmodic factor, using a powerful arteriolar vasodilator. However, we have begun the study by the same method of the effect of local treatment of the sclerosed vascular processes with iodine and its derivatives and with other substances that might be beneficial.

Which are the diseases we study?

1. Vascular functional transitory labyrinthopathies due to tensional variation or transitory arterial vasospasm. They are seen in hypertension, hypotension, endocrinopathy (climacteric), generalized or localized dystonias of the autonomous nervous system (cervical posterior sympathetic syndrome of Barré-Lieou[10] as frequent example of the latter). They may be of the vestibular type with definite Ménière's syndrome: vertigo and spontaneous nystagmus in the sudden movements of the head or upon changing the body's position, vertigo and nystagmus of position, deviations upon walking but without other signs, spontaneous or provoked, on vestibular examination, with normal audiogram, without alterations or neurological signs, or changes in the fundus of the eye, with normal urine and blood urea. The digestive endotoxicoses assume a clinical type identical with the labyrinthopathy, the reason being that in the last instance they work on the vascular labyrinthine system. They may be of the cochlear type with tinnitus or perturbation with false sensation of deafness, but without alteration on the audiogram. These labyrinthopathies do not require iontophoresis.

2. Vascular functional permanent labyrinthopathies due to prolonged angiospasm or to tissue alterations following the angiospasm, both reversible processes with possibility of improvement. They can be seen in Ménière's disease, in labyrinthine hydrops, and in Ménière's syndrome without hypoacousia. They may be of the vestibulocochlear type or Ménière's disease, or of the cochlear type constituting labyrinthine hydrops or the vestibular type or Ménière's syndrome. During the crisis there exist spontaneous symptoms, and the vestibular examination provokes various alterations. After the crisis the spontaneous symptoms generally disappear and few alterations brought on by the examination remain. The audiogram shows a fluctuating hypoacousia generally predominating in the low and medium tones, but that can be seen in the high tones; in general, all changes are reversible under iontophoresis with tolazoline. Audiometry in general demonstrates the beneficial action of iontophoresis with tolazoline. The vestibular examination also shows the beneficial action of tolazoline in iontophoresis. These patients have no alterations or neurological signs, not even in the fundus of the eye, and the urine and blood urea are normal. They are the more favorable types for iontophoresis with tolazoline and hyaluronidase.

3. Vascular organic labyrinthopathies or labyrinthine arteriosclerosis with or without superinduced spasm and appreciable only by means of iontophoresis with tolazoline. They may assume the vestibular type in general with Ménière's syndrome with very short crises of seconds of vertigo and lack of balance, and rarely with prolonged crises with nausea and vomiting very similar to those of Ménière's disease. We find alterations both spontaneous and provoked on examination during the crisis; and from it we can see permanent vestibular hyporeflexia or areflexia. The disturbances may be of the cochlear type, with very troublesome hypoacousia or tinnitus. The hypoacousia is also permanent and improves little with iontophoresis with tolazoline; there is generally a type of presbyacusia, but in the precocious cases at the ages of 40 to 50 years they can show a loss localized around 4000 or 6000 cycles. We already said this in 1946, and Saxén admits it in 1951. As Saxén says, we must not forget that in hypoacousia other extralabyrinthine processes may intervene, such as atrophy of Corti's organ or arteriosclerosis of the cerebral cortex. These labyrinthopathies may show favorable results with iontophoresis with tolazoline when the associated spasmodic vascular component is important.

In the three types of labyrinthopathies we can see general signs or symptoms of spasmodic vascular processes or of vascular organic processes, without being able to draw absolute conclusions for that reason.

The patient may have a spasmodic reversible labyrinthic process and an irreversible organic process in another artery of the organism. It is natural that the spasmodic process symptoms are more frequent in the first two and those of organic process in the third type of labyrinthopathy. As vascular spasmodic symptoms we find the following: nocturnal cramps in the calves of the legs or the soles of the feet, or "dead white" finger and tingling of the hands, intermittent claudication, slight transitory amblyopia, palpable suprasternal aorta, alterations on the ECC (unevenness of ST, collapse or inversion of T), albuminuria, uremia, and very important alterations in the fundus of the eye that every specialist should study, as we[11] said in 1946. These alterations are the following: localized or generalized arterial narrowing, increase of arterial brilliancy, invisibility of the blood due to thickening of the wall, disappearance of vein in arteriovenous crossing and dilatation at a certain distance of the same (Gunn's sign), invisibility, depression, compression, or deviation of the vein in the arteriovenous crossing, arteries without a column of blood, like fibrous cords (R. Rodriguez Barrios[12]). To sum up, symptoms in the three classic poles: heart, kidney, and fundus of eye.

Results obtained in nine months are shown in Tables 1 to 4.

TABLE 1.—*Typical Ménière's Disease, Seven Cases*

	Improved	Not Improved
Hypoacousia	6	1
Tinnitus	6	1
Vertigo	6	1

How do we evaluate the improvement?

We evaluate the vascular spasmodic component by the following:

(*a*) Improvement immediately or after two to four days of from 20 to 60 db. in the audiogram; improvement maintained for nine months, or improvement which, although it may disappear, is recovered with a new iontophoresis.

(*b*) Improvement of the tinnitus on audiometric acoumetry.

(*c*) Improvement in symptomatology and in some spontaneous vestibular signs.

(*d*) Improvement in the results of vestibular tests.

TABLE 2.—*Labyrinthine Hydrops (With or Without Initial Vertigo) Thirteen Cases*

	Improved	Not Improved
Hypoacousia	11	2
Tinnitus	8	4

We could make the objection that, as these are essentially dynamic processes with fluctuating and changeable symptomatology, we could consider spontaneous what is attributed to therapeutics; but the immediate result is so evident, so prolonged in many cases, is repeated every time the disease improves or worsens, and the improvement is so evident in the audiogram, in the measure or the disappearance of the tinnitus, and

TABLE 3.—*Ménière's Syndrome (by Vasospasm), Six Cases*

	Improved	Not Improved
Vertigo	5	1
Tinnitus	1 (5 without tinnitus)	

in the measure or disappearance of the vertigo or sensation of nausea that it gives us reason to be optimistic and trust in the great possibilities for the future of this new therapeutic method. Anyway, the results are better than those obtained with subcutaneous or intravenous histamine, or with intravenous procaine, or with a diet restricting liquids, salt, etc.

TABLE 4.—*Labyrinthine Arteriosclerosis (With or Without Vasospasm), Twelve Cases*

	Improved	Not Improved
Hypoacousia	4	8
Tinnitus	6	4 (2 had none)
Vertigo	1 (11 without vertigo)	

Report of Cases

Cases of Hydrops (already published in our previous work)

CASE 1.—A woman 21 years old consulted us on June 15, 1955, for a bilateral hypoacousia more

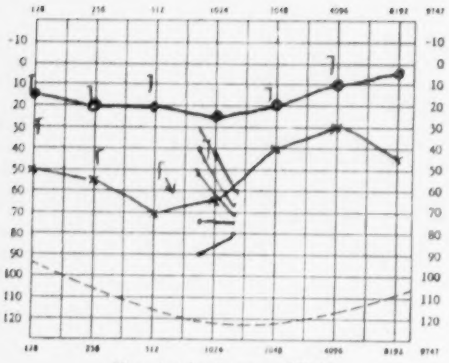

Fig. 3 (Audiogram 5797)

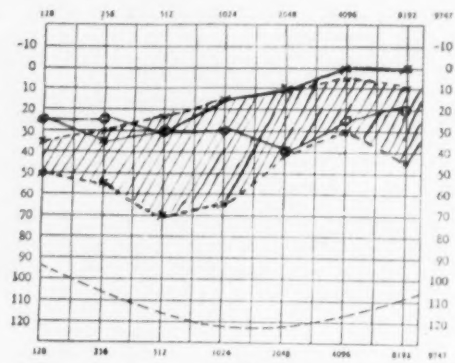

Fig. 4 (Audiogram 5840).—Improvement after first ionization in the left ear.

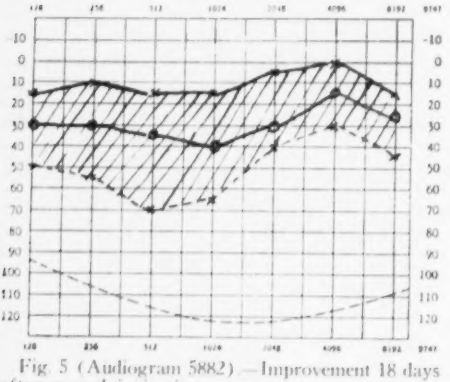

Fig. 5 (Audiogram 5882).—Improvement 18 days after second ionization.

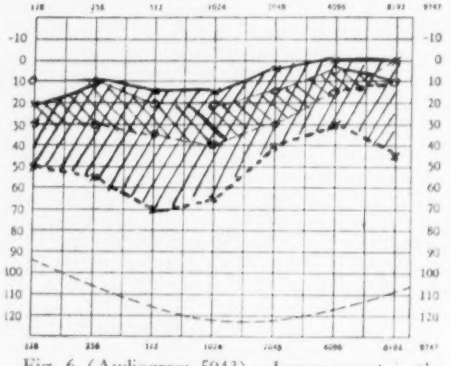

Fig. 6 (Audiogram 5943).—Improvement in the left ear greater than in the right.

intense in the left ear and a strong tinnitus in the same ear, symptoms that began suddenly three months ago with an initial rotatory vertigo with nausea and vomiting, lasting one whole day. The lack of equilibrium was so intense that she was driven by car from her job to her home, having to stop repeatedly because of the vomiting. The intense continuous tinnitus prevented her from sleeping one night. Strong voices echoed in the left ear in a different and disagreeable manner. A sensation of heaviness in all the head. She was treated as hepatic and nervous. At certain times she has had a fleeting sensation of lack of equilibrium.

We carried out intratympanic ionization on June 28, 1955. The patient thought she heard better, and the tinnitus decreased a great deal. The second intratympanic ionization was carried out in the left ear.

The patient returned 18 days after the second ionization without tinnitus, much better subjectively, and with an audiogram of almost normal curve for the left ear, surpassing that of the right ear, which had been the better one.

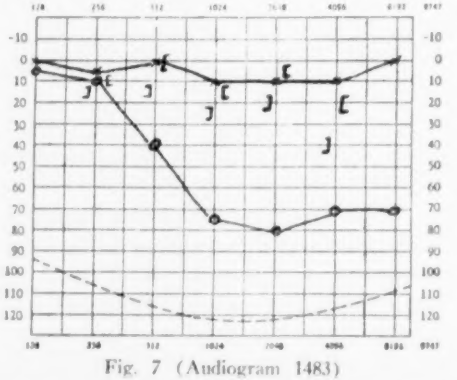

Fig. 7 (Audiogram 1483)

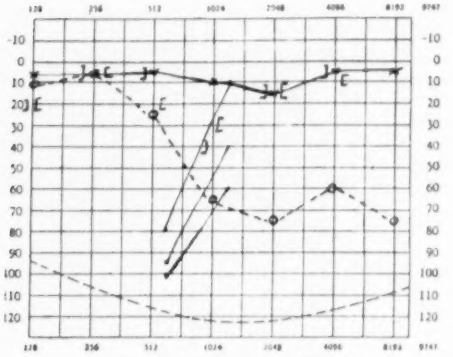

Fig. 8 (Audiogram 5855)

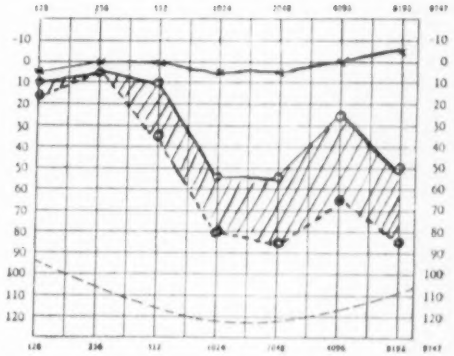

Fig. 9 (Audiogram 5887).—Improvement up to 40 db.

We then carried out another intratympanic ionization in the right ear, and examined the patient again 25 days after the ionization of the right ear and eight weeks after the first ionization in the left ear.

CASE 2.—A man 23 years old for 11 years has had hypoacousia of the right ear, actually without tinnitus, that began with rotatory vertigo, nausea, and vomiting, and that lasted, at that time, for several days. This was seen as a virosis of sudden onset, and received a test treatment with high doses of vitamin B_1 without any result. The caloric test showed normal bilateral response. The binaural balance test showed recruitment.

An intratympanic iontophoresis of only 15 minutes was made, and he returned 11 days later. He heard extraneous sounds when the ear was stopped and unstopped, with harsh, sudden sensations when the ear was unstopped. At no time did he have dizziness.

CASE 3.—A man 30 years old consulted us because for 10 days he had had a very strong tinnitus like a siren in the left ear, with hypoacousia in the same ear and painful sensation of voices and loud noises. For seven months he had heard an echo and had binaural tonal diplacousia. The noise tormented him so that at times he wished to remain deaf so that the buzzing would disappear. Three months ago he had a rotatory vertigo that lasted for seconds but was intense, with weakening of the legs. He is allergic; has had eczema of the external ear and does not take acetylsalicylic acid or its derivatives because it causes bilious vomiting without dizziness. Was treated lately by a specialist with drops for nose and ears and with an aerosol.

The first intratympanic iontophoresis of 15 minutes was performed. The next day he had great dizziness; afterwards he could hear better, and the buzzing had gone (therapeutic syndrome of Lermoyez). Since the day before the buzzing and deafness had begun again. The second intratympanic iontophoresis of 30 minutes was done. On returning he told how he got up two days later well, without hearing the echo as before. At times he hears a passing pulsing noise as: waff, waff. Yesterday, after seven months, he went to the movies and did not hear the echo heard before.

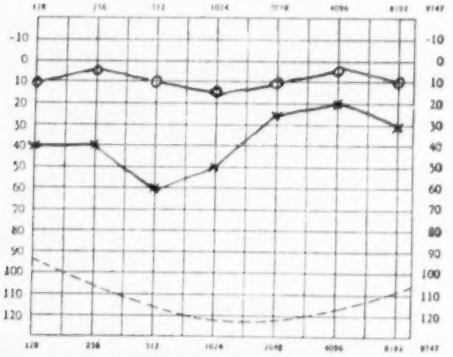

Fig. 10 (Audiogram 5904)

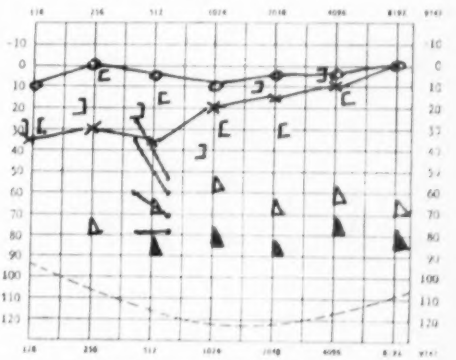

Fig. 11 (Audiogram 5895).—Indicating recruitment and discomfort by white triangles, and algiacousia by black triangles.

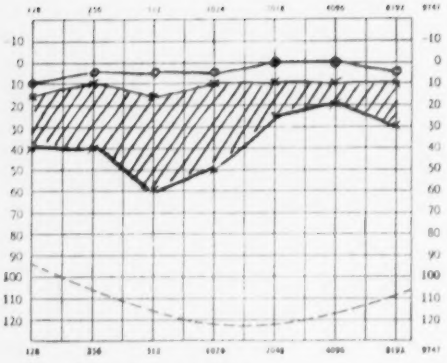

Fig. 12 (Audiogram 5911).—Improvement three days after the second iontophoresis.

Passed four months well, and the problems of a psychic nature intervened: on the one hand, emotional tension with excess work at his office, and, on the other hand, a problem of religious vocation that has troubled him and caused many nights of insomnia. Has followed a healthful diet, with little salt, and his liver functions well. About 20 days ago had acute vertigo with a sensation of downward movement of the surroundings. Strong buzzing in the right ear. Heard distorted sounds again and had echo-like diplacusis. A third iontophoresis of 30 minutes was performed on the left ear, and a week later the patient said that two days after the treatment he heard sounds as of bubbles and had very short, slight dizzy spells. Hearing improved little by little from the fourth or fifth day. The buzzing, the echo, and the sound distortion disappeared. Three months later we can prove that the improvement has been complete. The intense tinnitus felt during the crisis has disappeared and also a slight tinnitus which the patient felt for some 20 years, but which he told us about only now. The audiogram is normal.

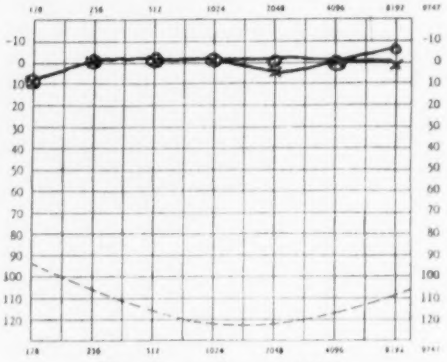

Fig. 13 (Audiogram 6421).

Some Cases of Ménière's Disease (not published in our previous work)

Case 1.—A patient 27 years old, with typical Ménière's disease with vertigo crisis, nausea and vomiting, hypoacousia of hydrops type with recruitment, diplacusis, and algiacusia; intense tinnitus that disappeared with the masking tone (Maico) with 50 db., with a tonality of 2000 cycles and 55 db.

Comment: The improvement in hearing is evident in the audiograms. The tinnitus decreased greatly on masking with 30 db. in place of 50 and with 2000 cycles with 25 db. in place of 55 db. Between the second and third iontophoreses has had vertiginous crisis but did not lose the audiometric gains or the improvement of the tinnitus to a corresponding extent.

Case 2.—A colleague 53 years old, with typical Ménière's disease, with vertigo in crisis, hypoacousia, and tinnitus. Treated by us with subcutaneous histamine, diet restricting water and

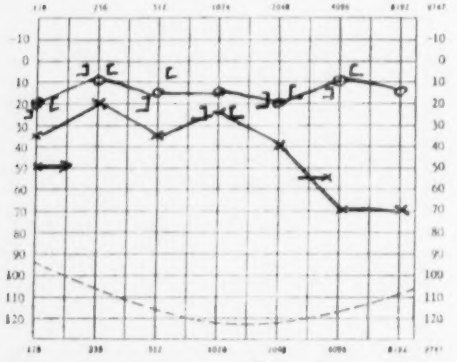

Fig. 14 (Audiogram 6340).—Before iontophoresis.

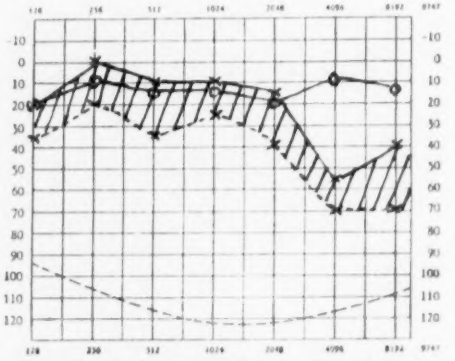

Fig. 15 (Audiogram 6340 a).—Immediate improvement after iontophoresis.

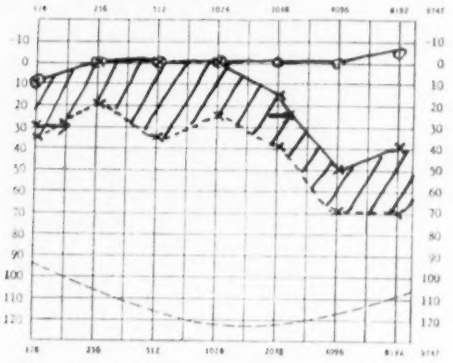

Fig. 16 (Audiogram 6413).—After the fourth iontophoresis.

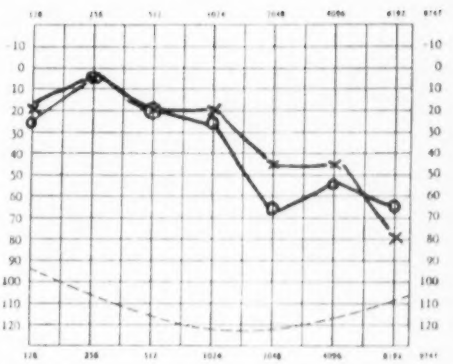

Fig. 17 (Audiogram 6390).—Before iontophoresis.

salt; diminution of vertigo obtained (with dimenhydrinate). Mersalyl (Salyrgan) was also given.

Comment: Evident improvement of hearing and of the tinnitus. Has had no more vertigo. The tinnitus increased the first days, then almost disappeared.

Case 3.—A woman 35 years of age. Typical Ménière's disease, with vertigo in crisis, hypoacousia, and tinnitus. During the crisis had nausea and vomiting. Binaural diplacusis and algiacusia. We performed three iontophoreses with tolazoline and hyaluronidase in the right ear, and the tinnitus decreased two or three days after the application. After the last application the tinnitus disappeared totally. In between the crisis of vertigo she had a sensation as if on board a ship and a slight vertigo on lying down. After two iontophoreses had no more vertiginous sensations.

Comment: Evident improvement of the high and medium tones. For that reason I believe there may exist a localized hydrops in the basal and medial spirals of the cochlea, instead of the hydrops of the deep tones as is now accepted (J. Lindsay) that would localize in the apical spiral of the cochlea.

Cases of Hydrops (not published before)

Case 4.—Patient 53 years old. After slight dizzy spells there appeared a fluctuating and changeable hypoacousia on audiogram of the right ear. Had a very loud noise in that ear. Diabetic patient with albumin, glucose, and acetone in the urine. Glycemia 1.68. Changeable arterial pressure, from 16/8 to 12/8. Was treated with diet and insulin. As the hypoacousia and tinnitus did not improve, was treated in 1949 with subcutaneous histamine, and in 20 days the audiogram was normal. The hypoacousia and the buzzing returned in eight months. Iontophoresis with tolazoline and hyaluronidase was performed, and in 14 days there was a net gain in the audiogram of the low and medium tones.

Comment: 1. There is vasospasm, inasmuch as the hypoacousia improved with a vasodilator. 2. Inasmuch as he is a well-

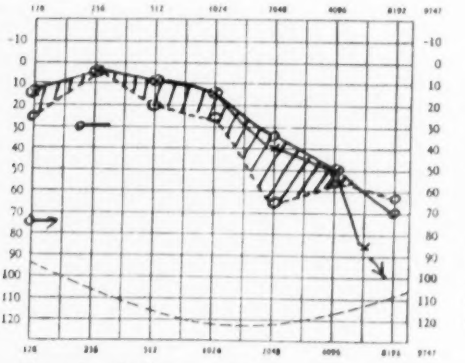

Fig. 18 (Audiogram 6416).—After the first iontophoresis (11 days later).

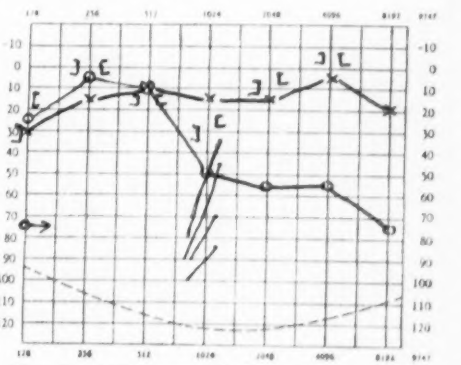

Fig. 19 (Audiogram 6382).—Recruitment and measure of tinnitus.

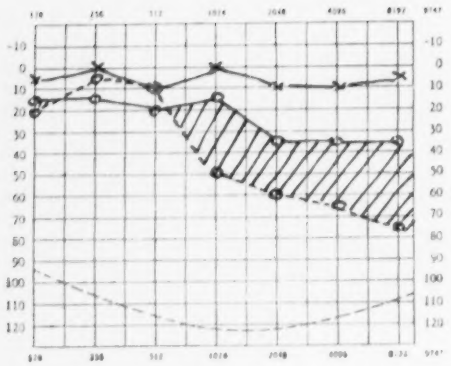

Fig. 20 (Audiogram 6343).—Twenty-one days after second iontophoresis.

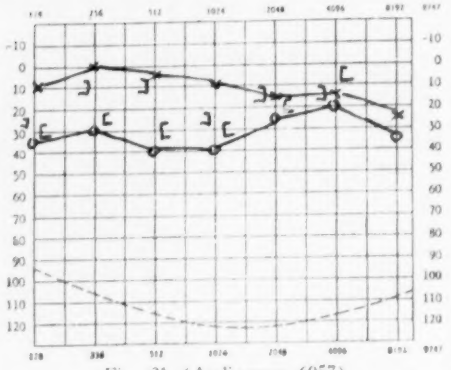

Fig. 21 (Audiogram 6057)

known diabetic of 53 years, we can suppose he is developing a vascular sclerosis but that the spasm is initial and accompanies the sclerosis as a reversible manifestation.

Case 5.—A spinster 45 years old. After an attack of vertigo in November, 1951, rotatory type, with nausea and vomiting, a fluctuating hypoacousia appeared in the right ear, and a noise like an intense and bothersome steam jet. Has also a syndrome of peripheral insufficiency with tingling, cramps, and coldness of the limbs. Is allergic and has had bronchial asthma and eczema. Was treated with organic iodine (Endoyodina) and antispasmodics (Sedocalcio), with vitamin B_{12}, with penicillin and cortisone. With this last treatment the audiogram improved somewhat. Then the hypoacousia and the intense tinnitus appeared and we performed two iontophoreses. The improvement showed immediately after the first iontophoresis and has remained the same for four months.

Comment: Allergic in menopause, appeared to have an auricular arteriosclerosis, but iontophoresis showed the existence of an evident vascular spasmodic element.

Case 6.—A man 69 years old. For years now, perhaps six or eight, hears less in the left ear. Has been treated with catheterization, and he believes he improves for only a few hours. In 1954 he noticed a slight deafness in the right ear with distortion of sounds, being able to appreciate this as is a violin player. In 1955 had two days with lack of equilibrium and a tendency to walk towards the right side. Tinnitus with the sound of running water in the right ear. This patient was treated as an arterioesclerose with iodine (Lipiodol, Endoyodina) and antispasmodics (Sedocalcio); was treated for hypovitaminosis with B_1, B_{12}, and multivitamins; was treated for hydrops with subcutaneous histamine, with procaine hydrochloride 2 parts in 1000 and nicotinic acid up to the flush dosage of 70 mg. the latter being given drop by drop by intravenous infusion daily for a week. All these treatments did not show variations in the audiogram. There was no sign to make us think of sclerosis. Arterial pressure 17-18.5, slight systolic hypertension without increase of the

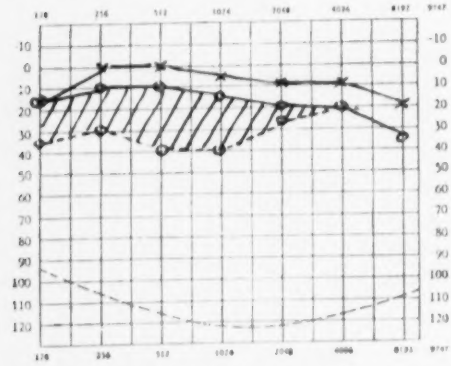

Fig. 22 (Audiogram 5097)

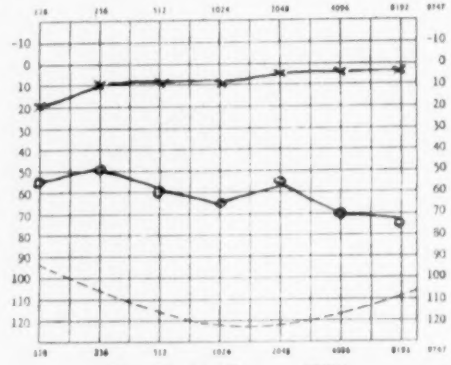

Fig. 23 (Audiogram 5982)

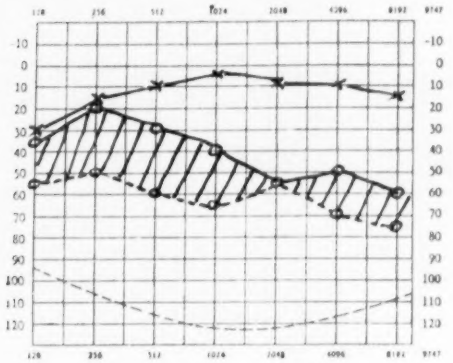

Fig. 24 (Audiogram 6252)

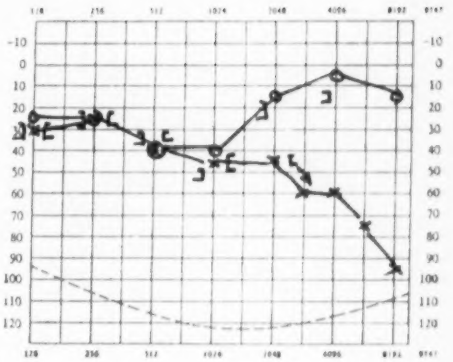

Fig. 25 (Audiogram 6071).—Displacusis 256, 512, 1024.

minimum. Fundus oculi normal. ECC normal. Urine and urea normal. Arterial oscillometry of limbs normal. With iontophoresis with tolazoline and hyaluronidase in the left ear ample improvement was obtained as shown in the audiogram, especially in the high tones (hydrops in the high tones) after three treatments. In the right ear we get an unimportant variation of 5 to 10 db. with one application.

Comment: In this case only the result of the iontophoresis shows there is vasospasm in the left ear, and not sclerosis due to the age of 69. In the right ear more applications should be made.

Case 7.—A man 30 years old. Has had severe tinnitus like a very troublesome buzzing in the right ear for two years; sometimes feels as if he had bubbles in the ear, as if it were stopped and unstopped. Sometimes has headaches. Has been generally healthy. Family health. Arterial pressure 11-7.5. Vessels in fundus of eye normal. General clinical examination normal. Lumbar puncture with normal fluid. Diplacousis. Recruitment. Measure of tinnitus. Three iontophoreses with tolazoline and hyaluronidase were done. The improvement of the audiogram was evident from the first iontophoresis. The buzzing disappeared for 24 hours after the first iontophoresis, and afterwards increased little by little until it reached the previous level. By studying the intermediate tones losses were observed in the 3000 tones and especially in the 6000 cycles, which makes us believe in a localized vascular sclerotic process. We have seen a patient with tinnitus in the 6000 tone, a person of about 35 years old, and we did not diagnose the condition. Some 15 years later this patient had a serious myocardial infarction well proved on ECC, and we believe that the two processes are related. This is the reason we have to believe in a sclerotic process. Another possible question would be acoustic trauma, as he shoots firearms in hunting.

Cases of Ménière's Syndrome (not yet published)

Case 8.—Patient 39 years old has for eight years had vertigo with rotatory sensation, sometimes with

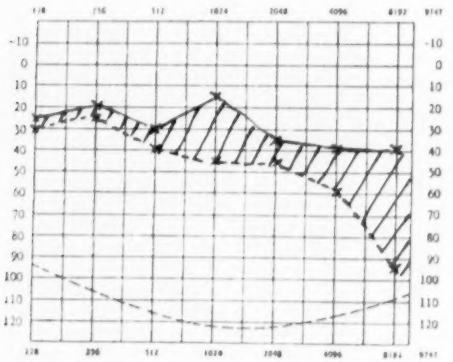

Fig. 26 (Audiogram 6166).—Improvement in the left ear.

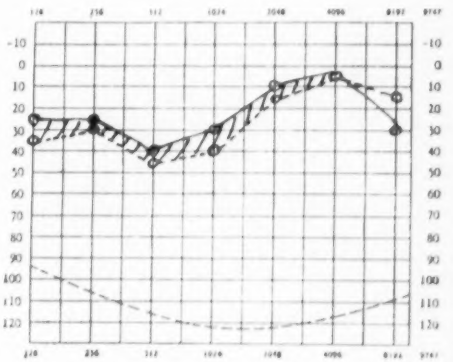

Fig. 27 (Audiogram 6142).—No change in the right ear.

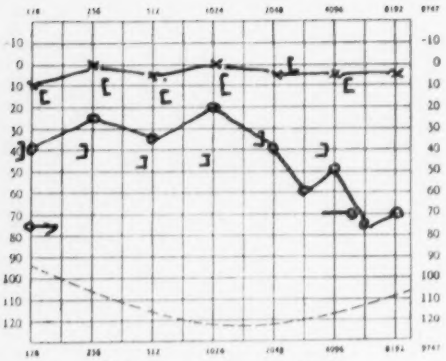

Fig. 28 (Audiogram 6262)

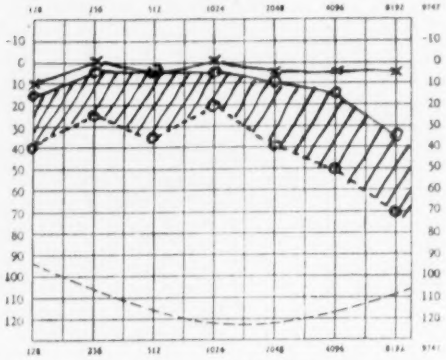

Fig. 29 (Audiogram 6315).—Improvement with iontophoresis.

nausea, that lasts for hours and at times one or two days. The last attack lasted 48 hours, from day before yesterday to yesterday. The crises come with intervals of weeks or months. During the crisis has a slight tinnitus in the right ear and seems to hear somewhat less in that ear. Has always been healthy. Has had arterial and capillary phenomenona with partial syndrome of Raynaud. No important abnormalities upon examination. Only shows a deviation in the blind walk towards the left and horizontal nystagmus to the right, in sudden movements of the head, or when changing position from sitting backwards or vice versa. There is no spontaneous or positional nystagmus. On the thermic test the caloric reflexes are normal, only the nystagmus and the vertigo are less accentuated in the right ear. The audiogram is normal. An iontophoresis with tolazoline and hyaluronidase was performed, and a week later the patient admitted not having the sensation of being aboard a ship, or having dizziness when moving her head, or when sitting or lying down. The improvement has persisted to this date (eight months).

Comment: Because of the favorable and evident evolution obtained with the iontophoresis with tolazoline, we can say that this syndrome of Ménière has a vascular spasmodic etiology. Besides, there is concomitance of a vascular spasmodic syndrome of Raynaud.

Case 9.—A woman 45 years old, who from the age of 5 years (school age) has had rotatory type of vertigo with nausea and vomiting, without hypoacousia or tinnitus. The vertigo improves with dimenhydrinate. With the vertigo has luminous sensations (phosphenes) but has no headaches. The attacks of vertigo come every 8 or 15 days. The last attack ended yesterday after lasting two nights and a day. Except for this has been healthy. The mother has suffered from migraine. No important abnormalities are found upon examination. We can find only a tendency to fall to the right in the Romberg, in the sudden movements of the head there appears the slow component of nystagmus to the right and in lateral left decubitus

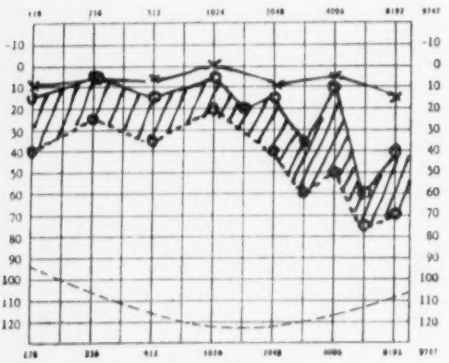

Fig. 30 (Audiogram 6349).—Searching for intermediate tones.

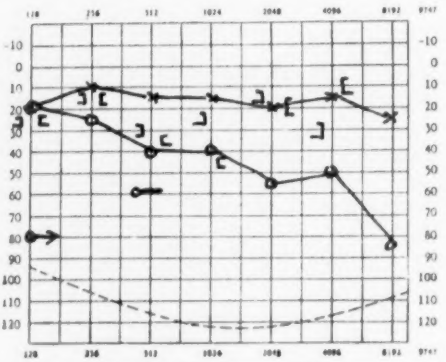

Fig. 31 (Audiogram 6314)

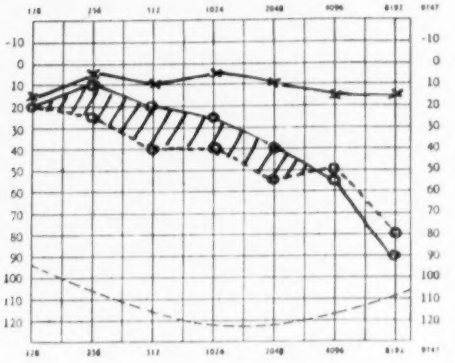

Fig. 32 (Audiogram 6317)

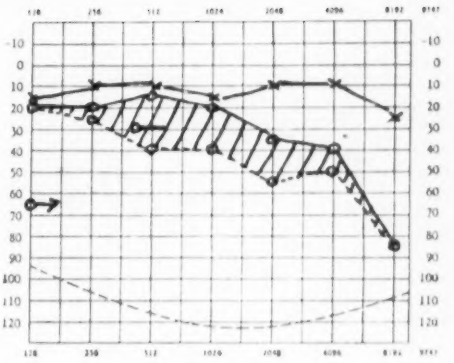

Fig. 33 (Audiogram 6426)

a clear nystagmus to the left. The rest of the spontaneous and provoked vestibular examination is normal. Normal audiogram. An iontophoresis with tolazoline and hyaluronidase was done, the left ear being chosen because of the appearance of nystagmus in the left decubitus position, but we confess we had doubts if it would not be necessary to treat the right ear because of the spontaneous nystagmus to the left (contralateral nystagmus in the labyrinthine processes of irritation). The fact is that the patient improved immediately, and the sensation of dizziness when moving the head or changing position disappeared. Six months have passed without vertiginous sensations.

Comment: Ménière's syndrome with phosphenes and family background of migraine that improves with iontophoresis.

Cases of Labyrinthine Arteriosclerosis with Vasospasm

Case 10.—A woman 73 years old has consulted us because she has not heard well in the right ear for two years now, and has a constant intense noise in the same ear as of a factory whistle. Has had no vertigo. Has a definite syndrome of peripheral circulatory insufficiency, with cramps, tingling, and in winter white fingers. At times a passing amblyopia. Has taken many medicines (polybromides, iodine, vitamins A, B_1, and B_{12}) without obtaining any result for the hypoacousia or for the tinnitus. Has been generally very healthy. No abnormality upon examination. The diapasons and the audiogram show a hypoacousia of perception in the right ear of the presbyacousia type. Measure of tinnitus: tone 512 with 60 db. and with masking tone of 80 db. Only one iontophoresis with tolazoline and hyaluronidase was carried out with 2 ma. for 15 minutes. When the application was finished, she already heard better, as was proved by the audiogram. After three months the improvement in hearing is maintained, and the tinnitus has decreased in intensity.

Case 11.—A man 60 years of age, has consulted us because for two years he has noticed deafness and noises in the ears which have become more intense lately, especially in the left ear. In July, 1955, had a myocardial infarction, and in spite of bed rest and medication believes buzzing has in-

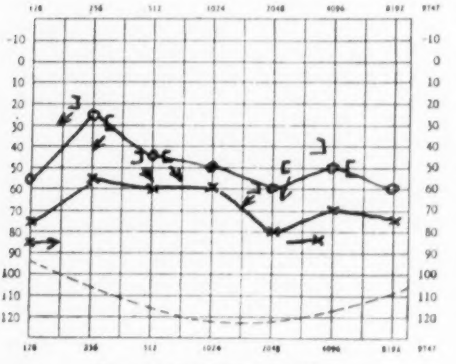

Fig. 34 (Audiogram 6276)

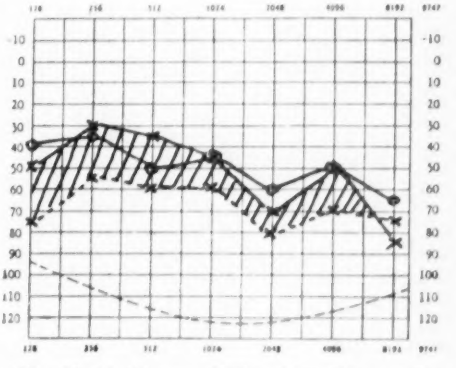

Fig. 35 (Audiogram 6277).—Immediate results.

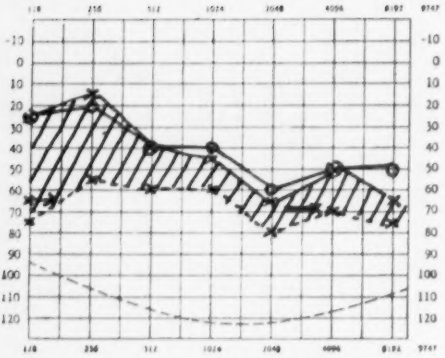

Fig. 36 (Audiogram 6358).—Eight days after the third iontophoresis.

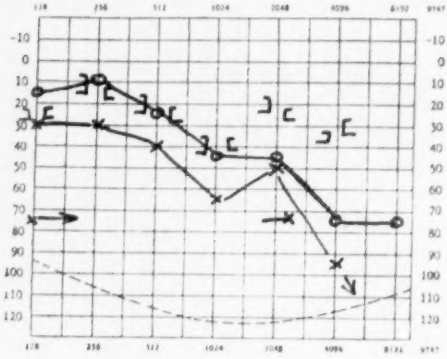

Fig. 37 (Audiogram 6334)

creased. Examination without abnormalities. Audiogram with bilateral hypoacousia of perception more accentuated to the left with loss of bone conduction around 1000 cycles and descent in the tone 128. According to Saxén's[18] histopathological studies in presbyacousia, the explanation would be as follows: The loss in the high tones would be due to the labyrinthine angiosclerosis (atrophy of Corti's organ, endolymphatic hypopression or compression, and sclerosis of the vascular stria) and the atrophy of Corti's ganglion; the impaired bone conduction to disturbance of endolymph production and to collapse of the cochlear canal; and finally, the ascent of the inferior limit tone to angiosclerosis of pathways and nervous centers. We believe these ideas deserve some revision because after iontophoresis with vasodilators we observe very interesting variations of the audiogram.

Comment: The patient had a myocardial infarction five months ago. We may suppose he has labyrinthine sclerosis generally due to his age and background; but the iontophoresis shows there exists a very important spasmodic component that must be treated in order to improve the patient. Importance of iontophoresis is in bringing out the significance of the vascular spasmodic factor, and also of the sclerotic component of the labyrinthic process.

Case 12.—A man 51 years old has heard poorly in the left ear for many years. Has nasal allergy with infectious congestion that presents a hyperplastic sinusitis on radiography of the two maxillary sinues as seen in allergic persons. After a simple extraction of a polyp had a hemorrhage that led to discovery of a paroxysmal arterial hypertension of 19-11. He later consulted us for the buzzing in the ears with 17-11 of arterial pressure,

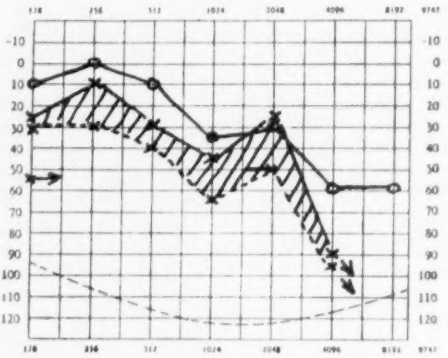

Fig. 38 (Audiogram 6355).—Seven days after iontophoresis.

nasal obstruction, and difficulty in hearing conversations and bells. At times has had the sensation of a lack of equilibrium. The examination shows allergic rhinopathy, dull tympani, and a concomitant pharyngitis. The diapasons show a hypoacousia of perception and the audiogram confirms it, the condition being more accentuated in the left ear. When told of the importance of the male climacteric on all his symptoms, the patient, surprised, confirms that, in fact, he has been receiving androgens for disturbances in potency and libido. Only one iontophoresis was done, and the noises almost disappeared from the left ear, the one treated; they and now appear to bother him on the other side.

Comment: The patient, allergic at male climacteric, has spasmodic hypertension that probably evolves to sclerosis. It is a process of multiple components, and they all influence the labyrinthine condition. The iontophoresis has brought about an improvement, and we can appreciate the spasmodic component of this particular case.

Importance of the Organic or Functional Vascular Processes of the Labyrinth

In a work we presented during a course given by us[14] in Valparaiso in December, 1952, when talking of the examination of vertiginous patients, we said that, of 387 cases treated for vertigo, the great majority, 142 cases, are cardiovascular: arteriosclerosis 110, hypertension 18, generalized dystonia 6 cases, hypotension 5 cases, sympathetic cervical posterior syndrome 2 cases, tensional instability 1 case.

In a course on tinnitus given in Montevideo[15] in October, 1955, we stated that of 1817 cases treated after otosclerosis with 850 cases of tinnitus (in 912 otosclerosis), the majority were of cardiovascular cause, 583 cases: arteriosclerosis 350, Ménière's disease 78, climacteric and menopause 72, hypertension 43, hypotension 27, sympathetic cervical posterior syndrome 13 cases.

In general medicine the importance of the cardiovascular processes and of the vascular diseases is well known. Wright,[16] speaking of the importance of arteriosclerosis, says that estimating at 25,000,000 the persons over 50 years of age in the United States, about 15,000,000 (60%) die because of some cardiovasculo-renal syndrome and only 2,000,000 (9%) die of cancer.

Up to this date there have been insufficient methods to evaluate the vascular participation in the labyrinthine processes. I refer to the study of arterial pressure, fundus of eyes, pressure of the central artery of the retina, electrocardiogram, oscillometric index, capillaroscopy. Even more, I consider insufficient to solve the problem the methods for studying the biochemistry of the arteriosclerotic process. There is not always observed a direct relation between cholesterolemia and arteriosclerosis. Nor do the more precise methods offer more security: (1) cholesterol-phospholipid relationship in the blood; (2) beta lipoproteins studied with the electrophoretic proteinogram; (3) study of lipomicrons on dark background. All these tests of statistical value have no individual diagnostic value. As A. Keys (Minnesota) says, "Arteriosclerosis does not depend on only one alteration of this medium and much less on its temporal modification that might be seen from a sample taken in a set moment."

Neither can histopathology clear the problem because it would not indicate anything in regard to vascular spasm, an essentially dynamic functional process and not histological; besides, in the majority of vascular diseases there is a spasmodic functional stage, and a typical example is arterial hypertension. We well know spasmodic arterial hypertension in acute nephritis or in eclampsia, where it falls from 300 to 120 and there remains no lesion in the renal arteries; Addis count shows normal function; and renal biopsy (with trocar), normal vessels and parenchyma.

Our method is a valuable contribution toward solving the great problem of the vascular diseases, a difficult and complex problem in all sectors of the organism and much more so at the level of the labyrinth, where there has been much discussion, where some deny the existence of spasm, and some even, like J. S. Riesco,[17] have denied the importance of the vascular factor in hypoacousia.

With our method we demonstrate the existence of vascular spasm and its absolute dependency, as regards therapy, on new methods, such as the one proposed by us.

Other Important Factors

We cannot get away from the importance of other factors—arterial hypertension, endocrine factors, female and male climacteric, the autonomous nervous system and its distonia—nor does any specialist with experience. For that reason we shall not go into their study, since they are an elemental subject known by all. Below we shall confirm the conclusions we reached in our former work and repeat and enlarge them.

Summary and Conclusions

In August, 1955, we presented the first studies of iontophoresis of the labyrinth and neighboring zones.

We showed the favorable therapeutic action of iontophoresis with tolazoline (Priscoline) and hyaluronidase (Wydase) in the permanent functional vascular labyrinthopathies (Ménière's disease, hydrops, Ménière's syndrome) and in the organic vascular labyrinthopathies with added vasospasm. The audiometric results have been better than those obtained with other therapeutic methods.

We bring a decisive contribution in support of the local theory of angiospasm in Ménière's disease, in hydrops, and in Ménière's syndrome due to vasospasm.

The method equally aids the labyrinthine localization of the various tests of recruitment, algiacusia, diplacusia, fatigue, etc.

It confirms the same pathogenesis for Ménière's disease, hydrops, and Ménière's syndrome.

The hydrops may appear with or without vertigo and may persist for years as a reversible process. The hydrops may likewise appear as a deafness of sudden onset.

The iontophoresis permits us to differentiate Ménière's syndrome by vasospasm from disturbances of another origin (infection, tumor, trauma, allergy, toxic, or degeneration process).

In Ménière's syndrome without hypoacousia and with areflexia to the caloric test, chronaxia permits the showing of the integrity of the first neuron and the iontophoresis its local origin by angiospasm.

If time permits the demonstration and confirmation of the good results of iontophoresis in Ménière's disease, the destructive treatments of the labyrinth would not be justified: medical (streptomycin) or surgical (alcohol, coagulation, ultrasonic, operations), or surgical section of the eighth nerve (Dandy).

Iontophoresis confirms the frequency of involvement of the spasmodic component in labyrinthine arteriosclerosis, with the possibility of improving many cases of hypoacousia, tinnitus, and vertigo.

Iontophoresis makes it possible to show that the hydrops may occur in the apical spiral (from 16 to 512 cycles) in the median spiral (from 512 to 2048 cycles), or in the basal spiral (from 2048 cycles to 11,584 and up), and that this process is generally reversible.

The presbyacusia curve on the audiogram does not always indicate a sclerosis or irreversible degenerative process, because iontophoresis makes possible improvement in many cases.

Iontophoresis has a differential diagnostic value in the labyrinthopathies and permits evaluation of the importance of the vasospasmodic factor, and its part in the development of sclerosis.

The good results obtained with iontophoresis in the vascular labyrinthopathies encourage the hope of other therapeutic successes in other labyrinthopathies in which therapy has been difficult or unsuccessful (specific or unspecific infectious processes, traumatic, toxic, or degenerative processes).

Enthusiasm for the new and successful method must not be carried to the extent of indiscriminate use of iontophoresis, inasmuch as it is not a therapeutic panacea. It is a new and efficient weapon in the otologist's hands, but one that requires careful study of the patient from the otological, neurological, and general point of view.

Bulevar Artigas 1507.

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Technique of Tympanoplasty

Report of Cases

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It is my opinion that every patient considered for operative intervention for relief of chronic draining ear should be considered a candidate for some form of tympanoplasty, depending, of course, on the amount of conductive hearing loss and cochlear potential. This is a report of 100 temporal bone procedures performed since 1951 for chronic draining ear in which attempt was made to salvage useful hearing from various types of residual destruction of the tympanum and its contents resulting from acute necrotic otitis media and from destruction due to so-called primary cholesteatoma. Some 65 other mastoidectomies performed during this same period either did not fit into the category of tympanoplasty or sufficient information was not available for satisfactory evaluation in this series.

It is not implied that tympanoplasty should be accomplished at the expense of failure to eradicate foci of infection or to jeopardize the patient's health with future complications but rather to effect both hearing improvement and elimination of disease whether it be with one- or two-stage procedures. With the use of the operating microscope, excellent illumination, the use of antibiotics, and the advantages of the endaural and transmeatal approaches to the middle ear cavity, the otologist is much better equipped to accomplish this than at any other time in medical history.

In 1951 I reported on hearing results of 38 mastoidectomies in which I emphasized the use of the operating microscope for the purpose of meticulously removing the diseased tissue from the oval and round windows, the hypotympanum, and the tubotympanum. Since that time the subject of reparative surgery of the middle ear has been a challenging one. A few good hearing results and many failures were experienced until, becoming acquainted with the work of Wullstein and Zöllner, I directed my procedures in accordance with their technique, with some modification for effecting closure of the tympanic membrane.

In Europe the subject of sound conduction following various reparative operative procedures for residually damaged tympana has been the focus of attention since 1949. In 1951 Zöllner reported the results of some detailed studies conducted on patients who had received radical operations several years prior to that time, some of whom received good hearing results, and others whose hearing had worsened following operation. After this, interest was created toward direct operative approaches to improve hearing while at the same time eradicating foci of infection. Moritz, Ombredanne, and Wullstein contributed considerable work in the journals regarding rehabilitation of the deafened ear in the years to follow.

In 1953 Zöllner published a paper on surgical techniques for the improvement of sound conduction after radical operation. In this series of cases, he made use of the binocular microscope furnished with an excellent system of maneuverability and a system of centered illumination, which allowed a very precise observation of the relationships in the tympanic cavity. He also reported on the specially constructed

Submitted for publication Feb. 18, 1957.

Presented as a candidate's thesis in partial fulfillment of requirements for membership in the American Laryngological, Rhinological and Otological Society, 1957.

acoustic probe of silver which he used to determine whether the vestibular and cochlear windows, the tympanic membrane, and the ossicles were functioning, or whether their function was blocked by adhesions. He further showed, with the use of the sounding probe, that in spite of absence of an ossicular chain, hearing may be adequately transmitted to the inner ear through either direct contact of the membrana tympani with the head of the stapes or by contact through cicatricial scarring as in the columella of birds. He therefore attempted in subsequent procedures to close the membrana tympani and place it in contact with the head of the stapes, maintaining a patent Eustachian tube and a normally functioning cochlear window.

Following the experience of Ombredanne in which he utilized a thin free graft to dry up a radical cavity and noticed an excellent hearing gain, Zöllner then followed the same procedure and found that the graft, if placed in apposition with the head of the stapes, served as an adequate substitute for the membrana tympani and transferred the sound directly to the head of the stapes. He further noted that where wider areas were to be grafted, the thin full-thickness graft served to hold up better. He also attempted in every case to adapt the flap to the upper half of the medial wall of the cavity so that the round window would be able to function properly in a smaller yet intact tympanic cavity. He attempted to conserve the mucous membrane of the hypotympanum and cochlear window where possible in order to allow for a functioning cochlear window membrane.

In 1953 Wullstein reported on 100 cases of tympanoplasty in which he attempted to attain a closed tympanum, capable of vibration, with a drum containing air, ventilated from the Eustachian tube to the fenestra rotunda, as well as the greatest effect possible of the sound pressure transformation. Wullstein also found that this result was obtained best with a thin full-thickness graft approximately 1 mm. in thickness, lined with absorbable gelatin sponge tampons. In a few cases he lined the hypotympanum and tubal region with ocular conjunctiva or amniotic membrane. At first, Wullstein placed free grafts "end to end" with the freshened margin of the drum membrane. Later, he stripped the epithelium from the drum membrane and placed the graft in apposition with the fibrous layer of the tympanic membrane.

Wullstein also observed the so-called "columella effect" and reported successful hearing improvements when the tympanic membrane or free graft was placed in contact with the head of the movable stapes. Again it was pointed out that an adequate air space was necessary and a membrane capable of vibration was of utmost importance. To accentuate this point he recalled the following: "As we know in transformation of sound pressure, on the way to the labyrinthine fluid, where proportion is of 1:22, only the smallest part is apportioned to the lever transmission of the chain of auditory ossicles (1:1.3); by far, the largest part falls to the surface condition of the tympanic membrane to the base of stapes (1:17), so the replacement by columella means little unless one succeeds in establishing as large a vibrating surface as possible within the transplant." This he attempted to achieve with absorbable gelatin sponge (Gelfoam) tampons, and on occasion he even lined the skin graft with mucous membrane in order to prevent the drum from adhering to the medial wall of the tympanic cavity.

In this country attention has been focused on these same procedures by such men as Juers, House, Baron, and others.

In attacking the problem of salvaging and improving hearing in the residually damaged ear one must consider the defects which may singularly or multiply present, and each case poses a problem unto itself. Therefore, assuming cochlear potential is good, one elects his choice of reparative surgical procedure, after evaluation of the functional capacity of the following: (1) the membrana tympani; (2) the ossicular chain and ves-

tibular window; (3) the cochlear window; (4) the hypotympanum and the tubotympanum.

The surgeon must realize that one or all of these structures may be involved, and either by preliminary evaluation or by careful analysis at time of operation, or both, his decision will direct his plan of attack for improvement of hearing.

The Membrana Tympani

It is well realized that the primary function of the membrana tympani is related to vibratory capacity and that when intact and functioning normally with an intact ossicular chain and tympanum it transfers a sound potential of some 1-22 ratio per square unit of measurement to the oval window. However, we have all seen patients in whom as much as 30% of the pars tensa is absent with central perforation with a conductive loss of only 12-15 db. After Linn therapy the hearing has returned to normal, discounting any intratympanic pathological process. It is further realized that a perforation anteriorly placed results in less hearing defect than a posteriorly placed one because of absence of shielding effect on the window, thus interfering with the phase relation between the two windows.

It is obvious, therefore, that not only can one not predict the hearing loss from observation of the perforation of the drum membrane, but he likewise cannot predict intratympanic pathology from the amount of hearing loss unless other tests such as the prosthesis test are performed.

One may generally classify drum pathology as follows:

Pars Tensa

I. Central Perforations: These are seen fairly frequently and for the most part are not associated with severe hearing loss. They are, as a rule, due to an acute suppurative otitis of benign type and many times are associated with chronic allergic otitis media. The so-called tubal perforations fall in this category and may or may not be seen with a discharging ear.

Occasionally one sees large kidney-shaped central perforations of the pars tensa which are end-results of acute necrotic otitis media associated with severe fulminating infection concurrent with scarlet fever, measles, etc. Many times these are associated with considerably larger conductive defects, not only because of the drum defect itself but because of residual damage to any of the structures previously mentioned; namely, the ossicular chain, the vestibular and round windows, or the tubo- and hypotympanum. Hearing defects in these cases may vary anywhere from 18% to 60% loss, depending on the type and location of pathological processes. There is also a small percentage of central perforations (1% in this series) associated with cholesteatoma due to adherence to the medial wall of the tympanum.

II. Marginal Perforations: These perforations, end-results of acute necrotic otitis media, are usually associated with chronic osteitis, cholesteatomatous formation, or both. Audiometric tests will almost always reveal a threshold curve for air well below the 30 db. level because of multiple defects in the ossicles and window areas.

Pars Flaccida

The so-called primary cholesteatoma, seen commonly, may be associated with any degree of pathological changes in the ossicles and the labyrinthine wall, depending on the extent of the cholesteatomatous invasion. Here conductive hearing loss may vary from 20% to 60%.

The Ossicular Chain

The ossicular chain, while constituting only a 1:1.3 ratio in the transformation of sound pressure, on the other hand may obstruct the transmission of sound with a drop of as much as 60 db., assuming normal vibrating drum capacity and cochlear potential. Adhesions at the incudomalleolar joint and calcification of the ossicular chain have been observed. Dislocation of the incus is occasionally seen, and erosion of the long process of the incus is a common finding.

Necrosis of the stapedial crura is often encountered. Ankylosis of the stapedial footplate at the vestibular window due to adhesions and granulating tissue is a not too infrequent finding, and otosclerotic focus must certainly be considered a cause of immobility in a small percentage of these cases.

The Cochlear Window

The round window niche may be obstructed with fibrous strands, cystic degeneration of the mucosa of the middle ear, and even bony ossification. Zöllner and Wullstein have observed the importance of freeing the cochlear niche of adhesions and granulating tissue, leaving a freely movable round window membrane in order to afford normal intralabyrinthine phase relationship. Normal function of the vestibular and round windows may be checked with the use of the acoustic probe and prosthesis test.

The Hypo- and Tubotympanum

While these portions of the tympanum are not vital components of the sound-transmission mechanism, it is important to give them meticulous care from the standpoint of removal of carious cavities and polypoid and cystic mucosal degeneration. Wullstein has advised that islands of healthy mucosa necessary for regeneration of a normal mucosal lining be retained to prevent adherence of the graft to the middle-ear wall. The tubotympanum, as well, must be inspected under high magnification for removal of adhesions and cystic degenerative mucosa, leaving normal mucosa where possible.

It is felt, however, that one cannot be too meticulous in the "toilet" of the hypo- and tubotympanum since these are common sources of persistent discharging ear following tympanoplasty. As we well know, from maxillary sinus surgery, mucosa has remarkable regenerative powers, and it is conceivable that the Eustachian tube mucosa would supply adequate regrowth of epithelium for the tympanic cavity provided all carious areas are removed.

The otologist, then, with this information in mind, must be able to analyze as completely as possible the functional capacity of the vital components of the ear.

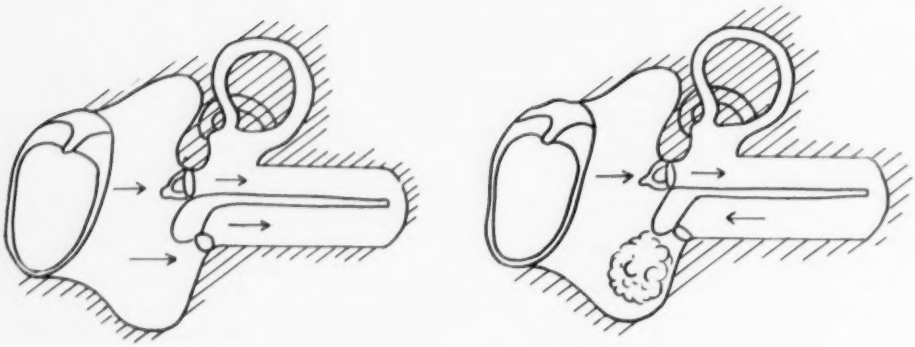
Diagnostic Tests

1. Pure-tone audiometric examination is made before and after operation, including bone conduction and fork testing for evaluating cochlear potential.

2. Tubal inflation is done under direct observation for testing tubal patency and vibratory capacity of the ear drum.

3. The prosthesis test is performed on those ears in which large perforation is present in order to evaluate the functional capacity of the ossicular chain and round window. When possible this is done in the office prior to operation. When the membrana tympani is present and prevents the test, the same is carried out at operation after mobilization and elevation of the ear drum. The prosthesis test is performed as follows: Oil-soaked cotton is inserted into the area of the round window, a patch of cigarette paper dipped in oil is placed over the ossicular chain, and audiometric testing is performed. All patients are operated on while under local analgesia and heavy sedation, and although results may not be absolutely accurate, owing to sedation, one can ascertain positive or negative prosthesis results with a fair degree of accuracy. A 15 to 20 db. or more improvement in pure-tone threshold curve for air is considered a positive prosthesis result, and functioning of ossicular chain and round window is established.

4. The *Schallsonde*, or acoustic probe, as developed by Zöllner, may be used in place of the prosthesis test with greater accuracy, since the probe may be pinpointed to any particular area of the cavum tympani for testing functional capacity. The probe may be obtained by writing the Georg Thieme Verlag, Stuttgart, Germany, and information regarding directions for use of the *Schallsonde* may be obtained by writing the Intercontinental Medical Book Corporation,



a. Windows unprotected b. Prosthesis

Fig. 1.—Diagram showing effect of sound on phase interval. (*a*) Windows unprotected and sound vibration entering both the vestibular and cochlear windows. (*b*) Prosthesis in place preventing sound from entering the cochlear window; therefore sound vibrations entering the vestibular window produce normal phase interval. Positive prosthesis test (a gain of 15 db. or more) indicates both windows functioning.

381 Fourth Ave., New York 16. The acoustic probe is of special value in testing the mobility of the stapes, and during the process of freeing the round window niche of adhesions and cystic mucosa the probe is most helpful in determining a normally functioning membrane.

Wullstein and Zöllner have established an orderly classification of tympanoplasty, depending on the type and location of defects presenting in the membrana tympani and the tympanic cavity. Figure 3 is a schematic drawing of Zöllner's "Schallsonde."

It must be emphasized that in all of these groupings, various types of defects may singly or multiply present, and for this reason I have divided the European classification into subgroups, depending on the drum defect present, for the purpose of better evaluation of the results of the type of plastic procedure employed.

Transmeatal Tympanoplasty

Perforation of Membrana Tympani—Pars Tensa

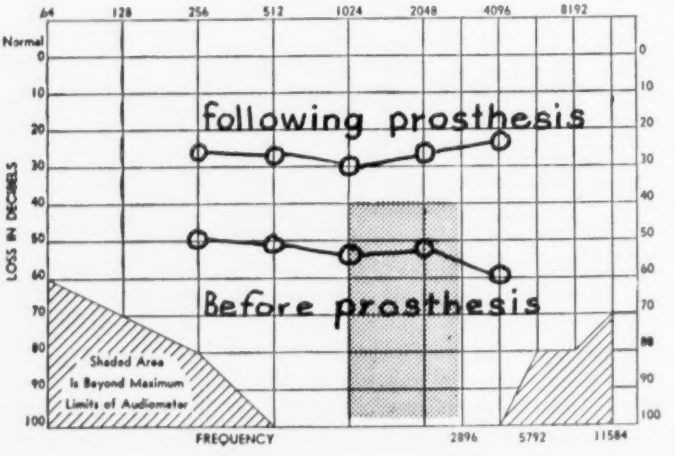


Fig. 2.—Pure-tone threshold curves obtained before and after prosthesis applied. Positive test indicated by gain of 15 db. or more.

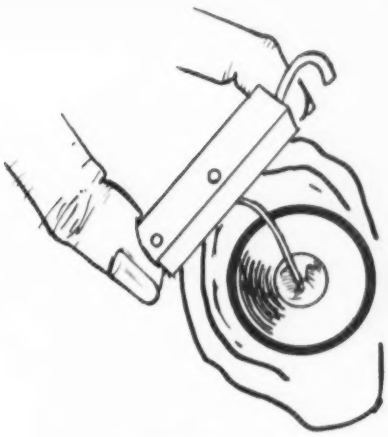


Fig. 3.—Diagram showing the application of the probe to the round window niche to test function of round window membrane. (From Thullen, A.: Die Schallsonde: Experimentelle und klinische Erfahrungen mit der Schallsonde nach Zöllner, Georg Thieme Verlag, Stuttgart.)

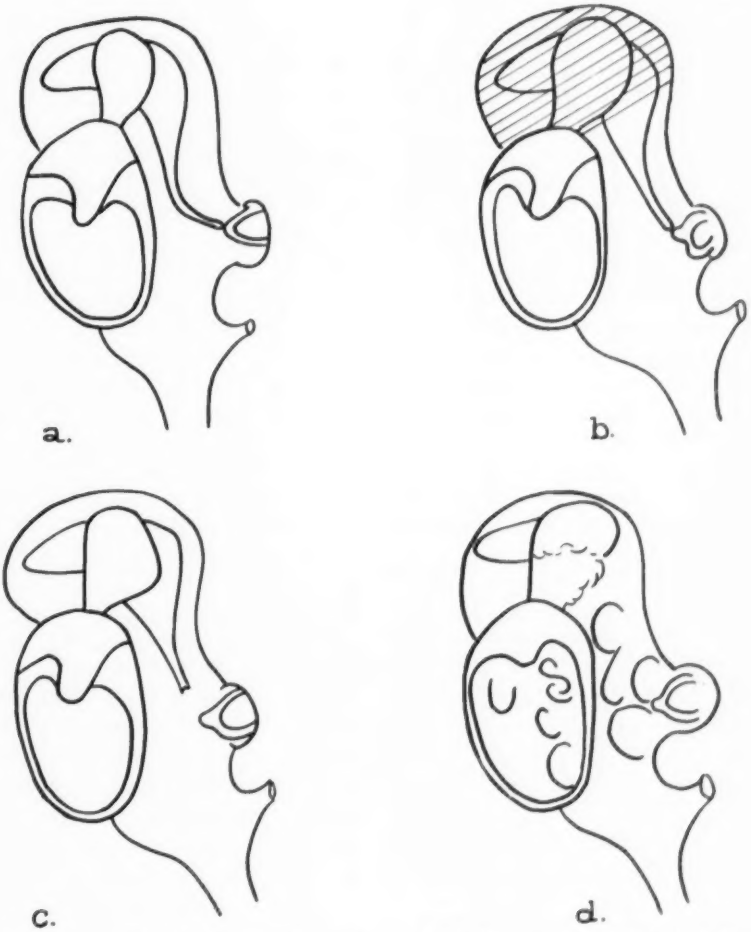


Fig. 4.—(*a*) Perforation of tympanic membrane without intratympanic pathological changes. (*b*) Perforation of tympanic membrane with pathological changes in the attic, as in cholesteatoma not permanently damaging the ossicular chain. (*c*) Perforation of tympanic membrane with interrupted ossicular chain. (*d*) Perforation of tympanic cavity with multiple defects in the ossicular chain, the vestibular and cochlear windows, the tubotympanum, and the hypotympanum.

I

Fig. 5.—Diagram showing large round or kidney-shaped defect of pars tensa with intact ossicular chain, mobile stapes, and functioning round window membrane, representing ideal lesion of transmeatal tympanoplasty.

Prerequisites

1. Large central round or kidney-shaped perforation resistant to Linn therapy
2. Complete absence of pars tensa without bony necrosis
3. Dry ear—no middle-ear pathology
4. Positive prosthesis test indicating mobile ossicular chain, mobile stapes, and functioning round window
5. Patent Eustachian tube on tubal inflation

Preoperative Medication

Preoperative sedation is obtained with pentobarbital (Nembutal) 1½ grains (0.1 gm.) and meperidine (Demerol) 50 mg., one hour prior to operation. An orthopedic sterile "prep" is carried out and bandage applied the night prior to operation.

Operative Procedure

Adequate infiltrative analgesia is obtained with 1% procaine solution and 1:1000 solution epinephrine in amounts sufficient to minimize hemorrhage. Since only a small amount of procaine is necessary to block the tympanic branch of the auriculotemporal nerve anteriorly and the auricular branch of the vagus posteriorly, 12-15 drops of epinephrine is advisable. It is necessary to remove the epidermal lining of the remaining portion of the tympanic membrane from the fibrous layer, and, since this epidermal layer is continuous with that of the external canal, one will observe many times the blanching and elevation of the epidermal lining of the tympanic membrane at the time of injection. Emphasis is placed on the time necessary for this procedure, and if one injects very slowly he will observe blanching of the canal followed by elevation and actual bleb of the epidermis of the remaining portion of the tympanic membrane in a large percentage of the procedures.

Denuding of the epidermal layer of the tympanic membrane is a meticulous and tedious process and should be carried out under high magnification of the operating microscope. If a bleb has been obtained as described above, it becomes an easy matter to remove the epidermis. To accomplish this I have used tiny corneal curettes and microscopic forceps. One must be exceedingly careful in order not to destroy the fibrous structure of the membrane. If this occurs, the drum will seemingly melt before the operator's eyes. Needless to say, it is important to preserve as much of the fibrous portion of the drum as possible, where such exists, since it not only serves as support for the free graft but it also serves as an excellent source of blood supply. The deep auricular artery is encountered inferiorly as one lifts away the epidermis, and the twigs of the tympanic branch of the internal maxillary artery are encountered at the annulus. Bleeding from these vessels is controlled with epinephrine tampons since a dry field is most important for grafting. In those cases in which the pars flaccida is intact it would seem desirable from the stand-

point of hearing gain to allow this to remain, freshening up the edges so that it may attach to the free graft. However, in recognition of the dangers of burying skin in a closed cavity and the possibility of cholesteatoma at a future date it would seem advisable to remove the epidermis and simple squamous inner lining at the expense of possible adhesions between the free graft and the exposed ossicular chain. Removal of the pars flaccida should then be routine.

The epidermis is removed from the entire inner half of the bony canal wall, thus affording an extra large bed to allow for contracture of the graft. One should be especially meticulous in removing the epidermis at the annulus so that there is complete denudation of the recipient site. If this is not accomplished, epithelialization from these islands will occur, resulting in loss of contact of the free graft and cholesteatoma.

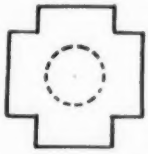


Fig. 6.—Split-thickness graft at least 1 mm. in thickness, covered with surgical silk, so that 000000 plain absorbable surgical suture may be inserted at corners and drawn together to form cylinder.

The postauricular area is preferred as the donor site. Not only is it more convenient, but the epidermis at this area is thick and the underlying mastoid bone serves as excellent support for the skin. A straight razor is preferred, and a thick split-thickness graft is obtained about 3 sq. cm. in size. The depth of the graft should be uniform and at least 1 mm. in thickness. This is then placed on surgical rayon, with use of Cortisporin ointment * to apply the cuticular layer to the fabric. The corners are cut as shown in Figure 6, and 000000 plain absorbable surgical sutures are inserted in the free edges of the graft, drawing them together to form a cylinder.

* Ointment containing polymixin B sulfate, bacitracin, neomycin, and hydrocortisone (free alcohol).

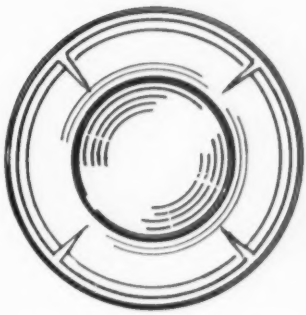


Fig. 7.—Cylinder of skin graft in place at annulus, supported by absorbable gelatin sponge and Cortisporin ointment and extending at least 1 cm. into the bony canal.

In those ears in which there is a fairly good rim of pars tensa remaining a small wad of absorbable gelatin sponge is placed in the hypotympanum, which is then covered with Cortisporin ointment. Cortisporin ointment is selected both because of its antibiotic powers and because it is felt that the cortisone will tend to minimize adhesions to the inner wall of the cavum tympanum. The graft is then applied to the recipient site and gently tamponaded at the annulus, making certain it is contacting for the full 360 degrees.

In those patients in whom the entire drum is being replaced the upper half of the cochlear promontory is denuded of mucosa. The area of the round window and the hypotympanum is protected with absorbable gelatin sponge and ointment, and the cochlear promontory is allowed to remain exposed, so that the graft may attach to the promontory as well as to the bony annulus. One must gently tamponade the graft firmly to the promontory for good contact. Again one must make certain the graft is in absolute contact with the bony annulus and inner portion of the external canal with no overlapping of edges. If overlapping occurs, sloughing will occur and rapid epithelialization of the epidermis of the canal wall will invade and undermine the graft. A small wad of cotton is inserted over the graft and surgical rayon. Firm pressure is applied so that there is even distribution of force

TABLE 1.—*Results in Seven Transmeatal Tympanoplastic Procedures*

Description of Lesions	Prosthesis Test	Preoperative Audiogram	Postoperative Audiogram	Results
1. Large kidney-shaped perforation; dry ear	Positive	30-30-45-50	10-5-10-15	M. T. intact
2. Complete absence of M. T.; dry ear	Positive, left right	40-45-45-10 50-55-60-65	25-20-20-15 30-35-35-50	M. T. intact
3. Absence of posterior ½ M. T.; dry ear	Positive	40-30-20-20	10-10-20-15	M. T. intact
4. Complete absence M. T.; dry ear	Positive	45-40-45-45	45-40-45-50	M. T. intact
5. Large central perforation resistant to Linn therapy	Positive	30-40-40-35	25-20-20-20	Small perforation
6. Absence of pars tensa with small marginal rim; dry ear	Positive	50-40-50-50	35-35-20-25	Deterioration of graft and cholesteatoma
7. Large kidney-shaped perforation	Positive	40-45-45-50	25-20-25-20	Deterioration of graft at 6 o'clock

in all directions. Another piece of surgical silk is placed over this as a landmark for postoperative dressing, and the canal is packed firmly with cotton soaked in Cortisporin ointment. The outer packing is removed in 7 days, and the inner packing is removed in 10 days.

Results in Seven Transmeatal Tympanoplastic Procedures

The relatively small number of transmeatal procedures in this large series of cases is understood when one realizes that transmeatal tympanoplasty is indicated only in those tympana where Linn therapy fails and where there are no middle-ear pathological processes present, as evidenced by normal mucosal lining and absence of discharge. Results are shown in Table 1.

Observations

From the standpoint of hearing rehabilitation one would compare these results favorably with those of the fenestration operation, in that five out of seven ears have reached a satisfactory hearing level. From the standpoint of closed tympania, however, there is much room for improvement.

Patient 5 presents an interesting observation in that persistent Linn therapy only seemed to enlarge his central perforation. Transmeatal tympanoplasty was performed, and the drum remained intact for six weeks, following which a small perforation appeared in the graft. There was a history of coryza, but no discharging ear. The assumption is made that the graft was ruptured on blowing the nose, before adequate tensile strength of the new drum was obtained.

Patient 6 presents an interesting complication, not to be minimized in that following the four-week dressing and removal of the surgical rayon support, there was noted a marginal dehiscence in the new drum at 6 o'clock. In spite of this there was noted a satisfactory gain in hearing. However, at the sixth-week examination the patient complained of decreased hearing acuity. Examination revealed a tympanic cavity full of cholesteatomatous debris which had invaded from the epithelial lining of the floor of the external canal, at 6 o'clock, necessitating revision.

Patient 2 received one of the best gains in hearing. The graft adhered posteriorly to the annulus and the handle of the malleus as well as to the cochlear promontory, but failed to bridge across to the canal wall anteriorly and inferiorly. Here is a patient, then, with a drum membrane of 50% vibratory capacity, closed tympanum posteriorly, and a pure-tone threshold level at the 15 db. level. The ear is dry, and the patient is happy.

The contralateral ear of the same patient presented the same large defect of the pars tensa and there was a preoperative level at the 55 db. level. An endaural tympanoplasty was performed, and a large free graft was placed over a normally functioning ossicular chain. In six weeks the graft deteriorated inferiorly, and there was little or no gain in hearing. Three months after the first operation a revision was performed by the transmeatal route.

The ossicles were again freed of portions of the previous graft, and a pedicle graft was prepared from the mastoid cavity. This

was placed at the annulus, covering the ossicular chain and supported beneath with absorbable gelatin sponge in the usual manner. The patient obtained an excellent hearing gain and an intact cavity. This is of importance to me in that from the standpoint of obtaining a closed tympanic cavity with thick split-thickness free grafts, this series of patients must be considered a failure. Since only four of the patients received a closed drum, it would appear that the pedicle graft is more reliable.

In the observation of the distressing incidence of deterioration of the free graft, it was noted that all of these occurred inferiorly, corresponding to 6 o'clock on the clock dial. I am convinced that the reasons for this are (1) inadequate removal of all epidermis from that portion of a fairly inaccessible canal surrounding the annulus, and (2) failure to prevent overlapping of skin edges and to attain proper apposition-ing of skin margins. This is most important and exceedingly difficult when one considers the small field of operation.

Endaural Tympanoplasty

Endaural tympanoplasty embraces Groups 2, 3, and 4 of the European classification in which intratympanic disease is manifest in various structures of the cavum tympani. Since it is felt that the results of the various types of procedures, whether they be with or without free graft, are of interest to the reader, I have classified this series of cases in accordance with the type of drum lesion presenting, the concurrent intratympanic defects encountered, and the type of graft employed.

Fig. 8.—Photo taken through operating microscope, showing large defect of pars tensa involving posterior half of tympanic membrane without intratympanic necrosis. Defect repaired by transmeatal tympanoplasty, and intact tympanum effected by means of free split-thickness graft attached to fibrous layer of remaining portion of tympanic membrane and the inner portion of the bony canal wall.

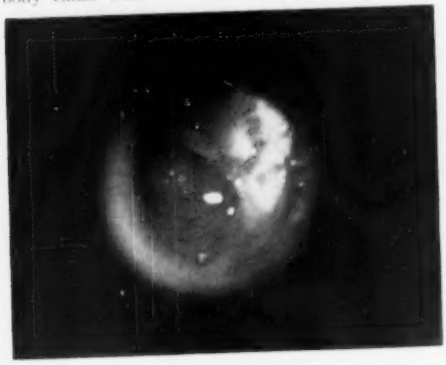


Fig. 9.—Transmeatal photo showing graft in place and lined with surgical silk.

Prerequisites

1. Perforation pars flaccida
2. Chronic discharging ear, either intermittent or persistent
3. Hearing impairment varying from 10-60 db loss

Procedure

With the patient under sedation of 4½ grains (0.3 gm.) of pentobarbital (Nembutal) and ½ grain (30 mg.) of morphine sulfate and dibucaine (Nupercaine) infiltrative analgesia endaural incision and tympanoatticotomy are performed. The cholesteatoma is removed in entirety from the mastoid antrum, the attic, and from the ossicular chain. After gently teasing away of all traces of the cholesteatoma, the ossicular chain is tested by mechanical manipulation for mobility. At this point if one wishes he may mobilize the membrana tympani, beginning at the posterior spine of the surgical bridge and extending midway posteriorly, corresponding to 9 o'clock on a clock dial. This will serve three purposes: firstly, a careful inspection of the tympanum; secondly, the application of the acoustic

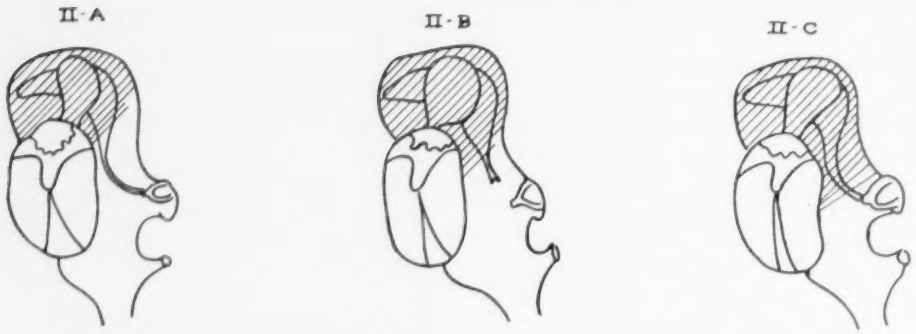


Fig. 10.—*A*, cholesteatoma pars flaccida, ossicular chain intact and functioning with mobile stapes and functioning round window; repaired by invaginating and overlapping pedicle flap. *B*, cholesteatoma pars flaccida, ossicular chain, broken at long process of incus; defects repaired by invagination and overlapping pedicle graft and attaching membrana tympani to capitulum of stapes (tympanostapediopexy) or preserving head of malleus contacting capitulum of stapes (tympanomalleolar stapediopexy). *C*, cholestatoma pars flaccida, ossicular chain ankylosed, stapes mobile and functioning; drum defect repaired as in *B*.

probe to the base of the stapes for the test of mobility, and thirdly, the application of the probe to the round window for testing function of the round window membrane.

If one should note a dislocated incus or absence of a portion of the bony process of the incus due to pressure necrosis of the cholesteatoma, or if one should note an immobile ossicular chain due to calcification, he must then resort to one of two procedures:

1. Tympanostapediopexy—the application of the drum membrane and tympanomeatal flap to the capitulum of the stapes, thus transferring sound from the vibrating drum directly to the capitulum of the stapes. The name was originated by Juers, and, as mentioned previously, the procedure has been recognized as an established surgical step in the improvement of hearing by Wullstein and Zöllner. The uncertainty of obtaining a fibrous contact between the inner surface of the drum membrane and the stapes may be reduced by (1) removal of the mucosa from the upper half of the cochlear promontory for attachment of the inner surface of the drum membrane; (2) escharring the inner surface of that portion of the drum which will contact the capitulum, and (3) invagination of the membrane flap into the niche occupied by the stapes, maintaining gentle pressure with a small pledget of sea sponge.

2. Tympanomalleolar Stapediopexy—The name of this procedure originated by me and first suggested by Baron—is worthy of mention. Baron suggested leaving the malleus in place, contacting it with the

Fig. 11.—Tympanostapediopexy. Stapes mobile, round window functioning as determined by prosthesis test or acoustic probe (*die Schallsonde*). Membrana tympani contacting capitulum of stapes.

TABLE 2.—*Results of Tympanostapediopexy (Lesions Pars Flaccida—Cholesteatoma)*

Preoperative Hearing				Prosthesis	Postoperative Hearing				Cavity Intact
256	512	1024	2048		256	512	1024	2048	
45	40	40	25	Positive	25	30	30	25	Cavity intact
40	55	50	60	Positive	20	25	30	35	Cavity intact

capitulum of the stapes in order to create a tent-like support of the drum, at the same time transferring sound to the vestibular window by way of malleus contacting the stapes. Two such procedures are reported in this series with excellent results. One should take precautionary measures not to exert too much pressure on the flap when placing the malleus head over the stapes as the Gellé phenomenon will be produced, thus reducing sound transmission. Perforation of the pars flaccida in this series is best managed by incising the margins of the defect, invaginating and overlapping the edges of the tympanomeatal pedicle flap. Surgical rayon soaked in Cortisporin ointment is placed over the entire area, and the cavity is packed with sea sponge.

TABLE 3.—*Results of Tympanomalleolar Stapediopexy (Lesions Pars Flaccida—Cholesteatoma)*

Preoperative Hearing				Prosthesis	Postoperative Hearing				Cavity Intact
256	512	1024	2048		256	512	1024	2048	
25	30	45	45	Positive	10	30	30	40	Cavity intact
20	35	35	30	Positive	10	15	30	25	Cavity intact

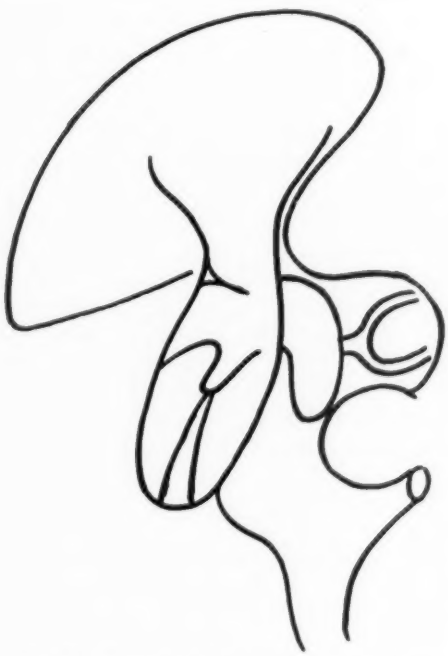


Fig. 12.—Tympanomalleolar stapediopexy. Stapes mobile, round window functioning as determined by prosthesis test or acoustic probe (*die Schallsonde*). Head of malleus left intact, contacting capitulum of stapes for transfer of sound and producing tenting effect of tympanic membrane as suggested by Baron.

The results of tympanostapediopexy and tympanomalleolar stapediopexy are shown in Tables 2 and 3.

Marginal Defects Pars Tensa

The third large group in this series represents those ears seen with marginal perforations due to acute necrotic otitis media. They are usually associated with bony necrosis, polypoid degeneration of the mucosal lining, and cholesteatomatous formation. These, for the most part, require more extensive plastic procedures of the drum, effecting closure by means of mobilization of the tympanic membrane and approximation of the edges of the perforation, or by free or pedicle grafts, depending on the size of the lesion. Here, too, intratympanic defects are extensive and many times multiple, demanding microscopic examination and use of the acoustic probe for analysis of the sound-conduction mechanism.

It is not implied from this method of grouping that one should expect less intratympanic pathology with smaller drum per-

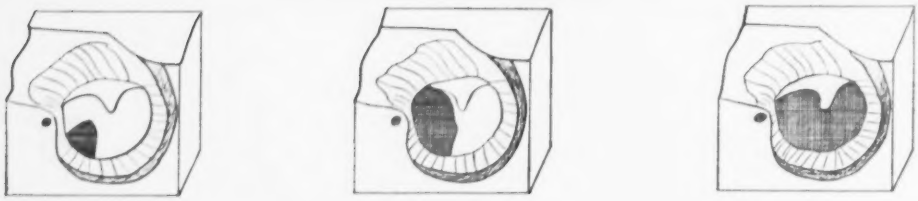


Fig. 13.—The above sketches show various types of marginal tympanic membrane defects, depending on the amount of necrosis of drum membrane involved, each requiring a distinct and individual type of plastic procedure in order to close the tympanic membrane. All are associated with intratympanic necrosis, granulation, etc., but may or may not be associated with ossicular chain involvement, vestibular window or cochlear window obstruction.

A, as described in the text, represents a small marginal defect which may be closed by mobilization of the drum, approximation of edges, and application of a portion of the pedicle flap. *B*, represents those marginal perforations involving 30% or more of the tympanic membrane. These perforations are also many times associated with multiple defects. *C*, represents a large marginal perforation involving all of the tympanic membrane associated with multiple defects. The cavum tympani reconstruction is effected with the use of a large free graft applied to the denuded inner surface of the bony canal wall, the upper half of the denuded cochlear prominence, and spread over the ossicular chain and horizontal semicircular canal.

forations than with large perforations. This, on the contrary, is many times the reverse. However, from the standpoint of management and conservation of residual tissues the above classification is elected.

Prerequisites

1. Marginal perforation of membrana tympani, foul discharges resistant to medical therapy.
2. Hearing impairment usually below the 30 db. level.
3. Good cochlear potential manifested by a good bone-conduction curve.

Procedure

A. Small perforations; effective means of closure—mobilization of tympanic membrane, approximation of edges, and overlapping with pedicle tympanomeatal graft.

With the patient under sedation and local analgesia the endaural incisions are made and a fenestration type of flap is prepared, the positioning of the pedicle of the flap depending on the position of the perforation. If the perforation is posteriorly placed, the pedicle is prepared along the anterior canal wall; likewise the pedicle is placed posteriorly if the perforation involves one of the anterior quadrants. This is necessary for proper mobilization of the drum membrane.

After tympanoatticotomy and removal of the surgical bridge, the tympanic membrane is mobilized and elevated for inspection of the cavum tympani and its contents.

Occasionally, as in acutely angled anterior fossa tegmen, it is necessary to mobilize the anterior portion of the membrane, folding it outward and into the external canal in order to visualize the tubotympanum. It may be detached from the manubrium if necessary, mobilized, except for its pedicle,

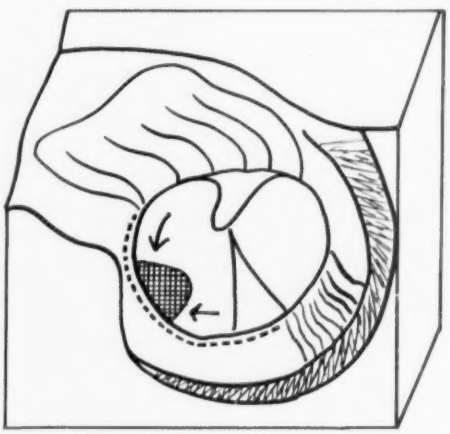


Fig. 14.—Diagram showing posterior perforation quadrant marginal perforation and anteriorly placed pedicle. Dotted line showing portion of drum to be mobilized for (1) inspection of cavum tympani, (2) performance of acoustic probe test, and (3) removal of carious tissue, after which drum edges may be approximated as shown by arrows.

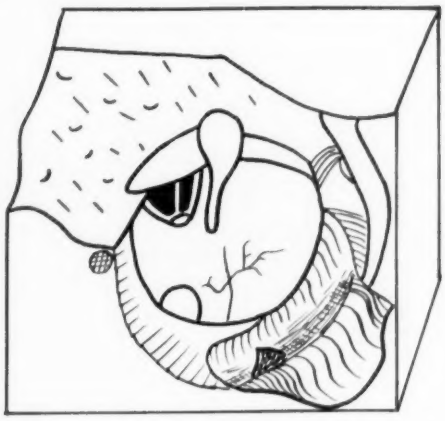


Fig. 15.—Marginal perforations with intratympanic necrosis; atticotomy performed, tympanic membrane mobilized, teased away from malleus handle and folded outward into canal or anteriorly placed pedicle, affording adequate inspection of hypotympanum and tubotympanum, at same time preserving ossicles.

and laid aside until intratympanic surgery is completed.

The following procedures are employed:

1. The ossicular chain is examined grossly and under magnification, if necessary, for defects, especially at the narrow portion of the long process of the incus.

2. Stapes mobility is ascertained by use of the acoustic probe. If granulation tissue is present in the area of the stapes, it is removed under magnification with slow and precise curettement. The probe may again be applied to the stapes to determine mobility.

3. The hypotympanum and tubotympanum are curretted thoroughly, making certain all caries is removed and maintaining normal tissue if present.

4. The round window niche is examined under magnification. Fibrous strands or cystic mucosa are removed, and again the acoustic probe is applied. If there is a gain of 15 to 20 db. or more above the preoperative pure-tone threshold curve, good window function is assumed.

5. In those procedures in which the ossicular chain is intact and both windows are functioning, after removal of pathological tissue, the hypotympanum and round window area is covered with absorbable gelatin sponge and Cortisporin ointment. The edges of the drum are freshened and approximated. The portion of tympanic membrane surrounding the perforation is denuded of epithelium, and the fenestration flap is placed in such a manner as to cover the approximated edges and denuded membrane.

6. If the incus is dislocated or eroded, tympanostapediopexy is attempted as in Group IIB, upon determining good function of the cochlear and vestibular windows either by the prosthesis or acoustic probe test.

7. If the stapes is found to be fixed and the round window functioning, a closed cavity is attempted as described, and the patient may be reserved for fenestration, provided the contralateral ear does not have serviceable hearing.

Results

Small marginal perforation, ossicles intact, perforation closed by mobilization of tympanic membrane and pedicle graft: 15 patients.

1. Hearing restored to practical level (30 db. or better)—9
2. Failure to improve hearing because of negative prosthesis test—1
3. Failure to improve hearing because of faulty technique although graft intact—1
4. Improvement of hearing, not to practical level because of cochlear impairment—1
5. Postoperative hearing not obtained—3
6. Persistent intermittent discharge—3

B. Marginal perforations involving 30% or more of the tympanic membrane, associated with osteitis and cholesteatoma, requiring free thick split-thickness grafts.

Intratympanic surgery is carried out as described above. A thick split-thickness graft is prepared. The remainder of the tympanic membrane is denuded of epithelium. The upper portion of the cochlear promontory is denuded of mucosa. The round window niche and the hypotympanum are protected with absorbable gelatin sponge and Cortisporin ointment. The graft is applied over the ossicular chain or to the capitulum of the stapes as the situation may present. Again, it is well to preserve as

much of the tympanic membrane as possible, since free grafting is much more effective when applied to the fibrous surface of the tympanic membrane.

The following is a case report of a 38-year-old woman patient with large posterior marginal perforation involving 50% of the pars tensa and cholesteatomatous debris, with pure-tone threshold curve for air at the 40 db. level and good cochlear potential. Endaura tympanoatticotomy was performed in the usual manner; the cholesteatoma was removed, and the long process of the incus found to be eroded, constituting a break in the ossicular chain. There was a positive prosthesis test elicited at operation; the acoustic probe placed at the round window showed a 25 db. gain over the preoperative threshold curve, and the stapes was found to be mobile. The remainder of the incus and the head of malleus were removed. The upper half of the cochlear promontory was stripped of mucosa for attachment of the free graft. The epidermal layer was stripped from the fibrous layer of the tympanic membrane, and the inner third of the bony canal was stripped of epithelium to complete the preparation of the recipient graft site. A thick split-thickness graft 1 mm. in depth was prepared, applied to surgical rayon with Cortisporin ointment, as described in the usual manner, and placed over the remaining tympanic membrane, with gentle tamponading applied at all places of contact. A small wad of absorbable gelatin sponge and Cortisporin ointment was placed posteriorly and inferiorly in the cavum tympani to support the flap over the round window, and contact of the graft was assured over the upper half of the cochlear promontory, the capitulum of the stapes, and the lateral semicircular canal. The edges of the free graft were approximated to the pedicle graft in the mastoid bowl. Six months after surgery the ear is dry; there is a closed tympanic cavity with vibrating drum, demonstrated on Eustachian tubal inflation, and the delineation between graft and drum remnant is not discernible. The postoperative hearing is at the 20-30 db. level.

Results

Perforation, 30% or more of tympanic membrane but with portion of membrane present for grafting and tympanostapediopexy: 15 patients

1. Hearing restored to practical level (30 db. or better)—5
2. Failure to improve hearing because of negative prosthesis test—3
3. Failure to improve hearing because of faulty technique although graft intact—4
4. Number of intermittent discharging ears—4

C. Complete absence of pars tensa with osteitis and/or cholesteatoma, tympanoplasty requiring complete replacement of drum membrane by free graft.

Procedure

Tympanoatticotomy is performed; all pathological tissue is removed from the cavum tympanum, and the function of the ossicles and windows is ascertained. Since this procedure requires a larger graft, the upper portion of the cochlear promontory is again denuded of mucosa. A wide area in the bony canal wall is denuded of epithelium, and a thick split-thickness graft is applied at the annulus, contacting the bony canal wall and the upper half of the cochlear promontory.

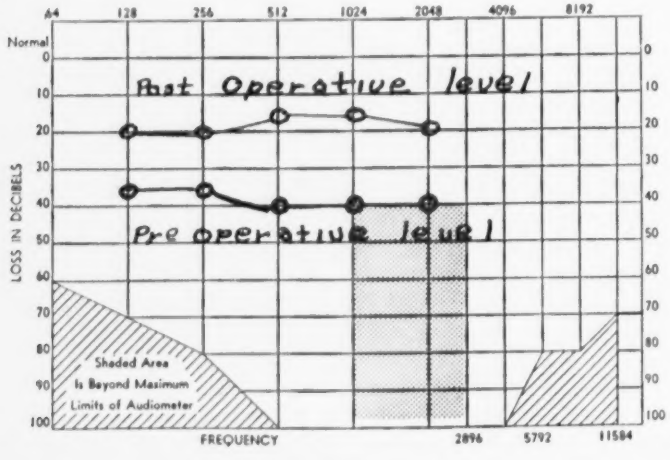


Fig. 16. — Pure-tone threshold curves for air revealing pre- and postoperative levels of hearing of patient who received endaural tympanoplasty for large marginal defect, cholesteatoma, and necrosis of large free graft attached to fibrous layer of remaining portion of tympanic membrane.

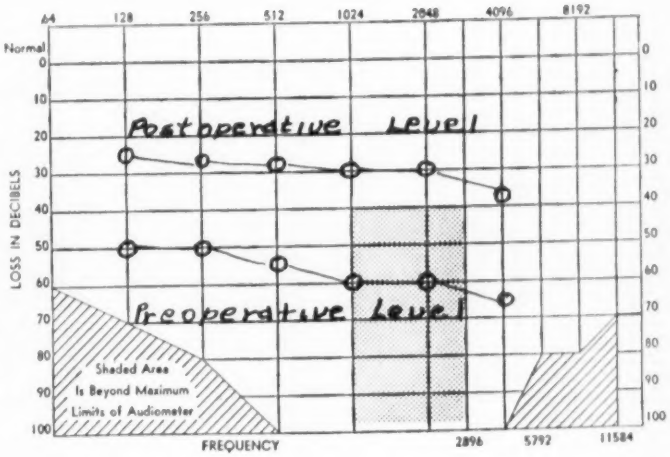


Fig. 17. — Pure-tone threshold curves for air recording pre- and postoperative levels of hearing of patient who received tympanoplasty procedure for complete absence of tympanic membrane, cholesteatomatous formation, and granulating tissue in the hypotympanum. The ossicles were found intact, and closed cavity was attempted by means of large free graft.

The following is a case report of a 28-year-old male patient seen with a history of intermittent discharge since childhood, complete absence of tympanic membrane, and hearing at the 60 db. level. In view of evidence of intratympanic disease, endaural tympanoplasty was elected. Tympanoatticotomy was performed in the usual manner, and the ossicles were stripped of cholesteatomatous debris. The ossicular chain was found to be intact, the stapes mobile, and the round window functioning, as demonstrated by the prosthesis test. The hypotympanum and tubotympanum were stripped of redundant mucosa. Absorbable gelatin sponge and Cortisporin ointment were placed in the hypotympanum in the usual manner and the inner-half of the bony canal wall was stripped of epithelium. A thick split-thickness graft was prepared and placed over the ossicular chain and the gelatin sponge support, and gently tamponaded to the bony canal walls. Eight weeks postoperatively, there was noted a small dehiscence of the graft at 6 o'clock. Eighteen months postoperatively, the ear has remained dry; the small dehiscence has not enlarged, and the postoperative hearing level is at or slightly above the 30 db. level.

Results

Complete replacement of M. T. with free graft, ossicles intact: 12 patients

1. Hearing restored to practical level—7
2. Failure to improve hearing because of faulty technique although graft intact—2
3. Failure to improve hearing because of deterioration of graft—3
4. Intermittent discharging ear—2

Complete replacement of M. T. with free graft—stapediopexy: 14 patients

1. Hearing restored to practical level—3
2. Failure to improve hearing because of negative prosthesis test—2
3. Failure to improve hearing because of faulty technique although graft intact—3
4. Postoperative hearing results not obtained—3
5. Intermittent discharging ear following deterioration of graft—2

Free graft—all ossicles removed, foot plate ankylosed, round window functioning; attempt to create new tympanic cavity; reserved for fenestration procedure: 12 patients.

1. Number of closed tympanic cavities—7
2. Number of dry ears but graft deteriorated at 6 o'clock—3
3. Persistent postoperative discharge—2

As mentioned previously, there is a considerable number in the Group III cases in which the stapes is completely ankylosed, as demonstrated by the negative prosthesis test or by negative sound probe test. If the round window can be determined as functioning, after the freeing of adhesions and cystic mucosa, and if an air space enclosed with an epithelial graft is obtained over the cochlear window extending to a patent Eustachian tube, the patient may then be considered for fenestration. The patient is not considered for this procedure unless, of course, the contralateral ear is found incapable of receiving sound above a practical level. While a number of ears in this series are candidates for the secondary fenestration procedure, only one thus far was found

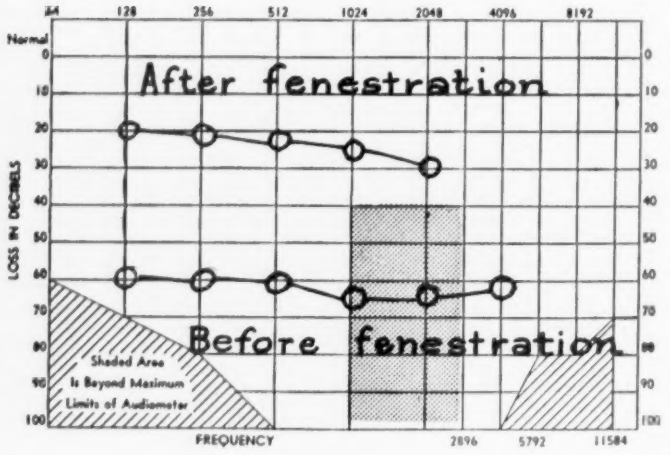


Fig. 18. — Pure-tone threshold curve for air demonstrating threshold of hearing prior to and one year after fenestration of the horizontal semicircular canal in a mastoid cavity in which the ossicular chain was removed. The stapes was found immobile and the oval window found functioning. This represents a two-stage procedure, the first operation being performed for removal of carious tissue and reconstruction of the tympanic cavity with free graft. Hearing rehabilitation was obtained by fenestration as a secondary procedure.

suitable because of the latter indication. This 46-year-old patient received tympanoplastic procedures in both ears on separate occasions, at which times there was noted complete destruction of the ossicles and massive necrosis of the cavity. The stapes were ankylosed bilaterally. The round windows were freed of adhesions, and free grafts were applied in an attempt to maintain an air space lined with mucosa and closed with an epithelial membrane capable of vibration in the usual manner. Audiometry revealed pure-tone threshold curves below the level of adequacy, and fenestration of the right ear was considered since cochlear impairment received at the time of acute necrotic otitis onset prevented adequate hearing in the contralateral ear.

The preoperative threshold curve was noted at the 60 db. level. After fenestration, the patient received a hearing level of 25 db. loss and is now completely rehabilitated.

Summary and Conclusions

Tympanoplastic procedures in this country and Europe are reviewed.

A series of 100 tympanoplastic procedures and results are presented.

Transmeatal tympanoplasty is reserved for the following: (*a*) large central or kidney-shaped defects; (*b*) marginal defects without intratympanic necrosis; (*c*) patent Eustachian tube; (*d*) dry ear, and (*e*) positive prosthesis or probe test.

Endaural tympanoplasty is reserved for (*a*) lesions of pars flaccida with so-called primary cholesteatoma, and (*b*) marginal defects with intratympanic necrosis.

Tympanostapediopexy and tympanomalleolar stapediopexy are demonstrated with report of good results in most cases.

Free thick split-thickness grafts are used with good results only when (*a*) special care is taken in preparing a large bed completely free of islands of epithelium to receive the graft; (*b*) the graft is uniform in thickness and at least 1 mm. thick; (*c*) the defect to be bridged is not too large, in which cases the promontory of the cochlea is used as a contact, and (*d*) the free graft is in good contact with the "bed"; there is no overlapping of edges and the margins are in good apposition with the meatal epithelium.

Pedicle grafts are preferred to free grafts where possible.

It is demonstrated with report of results that satisfactory hearing can be obtained in residually damaged ears from tympanoplasty procedures either in one or two stages, if one adheres to certain principles, namely, (*a*) evaluation of function of ossicles, stapes mobility, and round window function, (*b*) removal of all carious tissue; (*c*) maintenance of a mucosa-lined cavity ex-

tending from the cochlear window to a patent Eustachian tube, and (*d*) the reconstruction of an intact vibrating drum.

Fenestration, as a secondary procedure, may be performed with excellent results, provided a mobile round window membrane is present.

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Audiology Section

JOSEPH SATALOFF, ASSOCIATE EDITOR

Binaural Hearing

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The terms "binaural hearing" and "stereophonic sound" have caught the imagination of all who are interested in sound and its electronic reproduction as well as those of us who are interested in hearing and deafness. Stereophonia has become the central theme of the dazzling high-fidelity fairs which have visited the nation's largest cities during the past few years. More recently, in the field of hearing impairment there has been a rapidly expanding interest in the functional differences between monaural and binaural hearing and in the relative advantages of the latter. The revival of clinical and experimental activities in this area has been stimulated in part by the recent development of new surgical techniques for the relief of deafness and by the practical miniaturization of the modern hearing aid. An increasing amount of research is also being carried on in the field of message communication.

A brief search of the literature reveals the information that patents on stereophonic broadcasting were applied for in 1921, while binaural broadcasts were tried as early as 1925 by more than one radio station, only to be abandoned because of the crowding of the available AM channels as the broadcast industry grew. Hirsh reports that a patent for a stereophonic hearing aid was obtained by C. Soret in 1912[1] ! Bibliographies on hearing and on the reproduction of sound include scattered references to the subject before the turn of the century.[2]

Accepted for publication Jan. 26, 1957.

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Much of the present interest was stimulated by an unobtrusive but important Letter to the Editor of the *Journal of the Acoustical Society of America* by W. Koenig in 1950.[3]

As though to add to our frustrations over terminology in the field of impaired hearing, we must now try to decide upon the meaning of "binaural hearing," "binauralization of hearing," "stereophonia," "astereophonia," etc. It is recognized that the term binaural means simply two-eared. Since this has seemed to some to be too vague to distinguish between the condition where sound is fed to the two ears from a single microphone or amplifier and one in which each ear is fed separately by a completely independent system, including microphone, amplifier, and earphone, the term "true binaural" has sometimes been used for the latter. The term stereophonic as used in the field of music reproduction has been intended to convey the idea of "sound in the round." With a bow to a developing tradition and with a feeling that the term stereophonia is somewhat pretentious at this time, I shall use the simple term binaural in this paper to mean the condition of two completely separate systems, one for each ear.

Differences Between Monaural and Binaural Hearing

Following are the claimed advantages of two-eared over one-eared hearing: (1) localization; (2) selectivity; (3) better discrimination in quiet and in noise; (4) ability to identify common sounds; (5) ease of listening; (6) better "quality" of sound.

1. Localization

The most dramatic advantage seems to be in the ability to determine the direction and distance away of a sound source. Those who are concerned with the psychoacoustic explanation of this phenomenon believe that normal judgments of localization are based upon the following: (1) the relative time of arrival of sound at the two ears; (2) the difference in phase of the sound at the ears; (3) the difference in intensity of the sound at each ear, and (4) the difference in frequency spectrum of the sound at each ear due to the diffraction effect around the head, affecting particularly the higher frequencies. A fifth factor, often omitted, is the difference in hearing between the two ears, involving such aspects as over-all sensitivity, sensitivity as a function of frequency, distortion, etc. It has also been suggested by some writers, most recently by Cherry and Sayers, that our ability to localize quickly stems from our accumulated experience with "what people sound like when speaking in corners of rooms, in doorways, near windows, etc."[4] This observation, although appealing on the surface, is subject to question. Adults who have been severely hard of hearing most of their lives localize correctly immediately upon hearing with two hearing aids properly placed on the head, although they could not previously with a monaural aid. One such case involving a blind subject will be discussed later in this paper.

Preliminary Study of Localization as a Function of Intensity.—It has seemed to me that in the case of persons with markedly different thresholds in the two ears the ability to localize depends primarily upon the intensity of the sound. In order to study this observation more closely a preliminary investigation was undertaken, the results of which will now be reported.

Subjects: In order to avoid the introduction of factors peculiar to amplification, the preliminary study was conducted on five persons who had varying differences in the thresholds of their two ears rather than with monaural and binaural hearing aid conditions. Figure 1 shows the audiograms of the subjects.

All five subjects had undergone surgery of the stapes for the improvement of their hearing. In four cases the subjects had relatively equal hearing in both ears before surgery but after successful manipulation or perforation of the stapedial footplate showed considerably better hearing in the ear that had been operated on. The fifth subject showed essentially the same hearing before and after surgery. The audiograms shown are all postoperative. If patients such as these are questioned about their ability to localize sound before and after surgery, it is often reported that, along with the happy circumstance of the improvement in hearing acuity they now notice some localization confusion which was not present prior to the improvement in the one ear.

As a control and in order to expose any unusual acoustic factors in the test area which might affect the localization of the subjects at various levels of intensity, normal hearing subjects were tested first. In all cases these subjects localized accurately at all levels from 10 db. above their sound field detection thresholds to the upper limit of the equipment, with the occasional exception of the overhead sound source. Since that particular localization is quite unrelated to our usual experiences and proved difficult for normal listeners, the overhead source was not included in the scoring of errors for the experimental subjects although it was included in the test series.

Equipment: In the control room of a two-room test arrangement a tape player fed spondee words into a power amplifier, the output of which led to a selector box with one spring-return push-button switch for each loudspeaker in the test room, as shown on Figure 2.

Procedure: After conventional pure-tone and speech audiometry had been accomplished, the detection threshold for spondees was determined for each ear. Then the subject was seated in the test room facing the front speaker, and his sound field detection threshold for the spondees was obtained. The detection threshold rather than the speech reception threshold was used in this study since the judgment required was only that of localization, without attention to recognition of the words. The position of each of the other loudspeakers in the room was then pointed out to the subject and he was instructed to indicate where each test word came from, moving his head around as necessary. Obviously this is a variable in the procedure, the effects of which are to be studied in the continuation of these investigations.

The test material (spondee words) was presented in a randomized order, each source being included twice, for a total of eight presentations at each test level. One or more spondees was included in

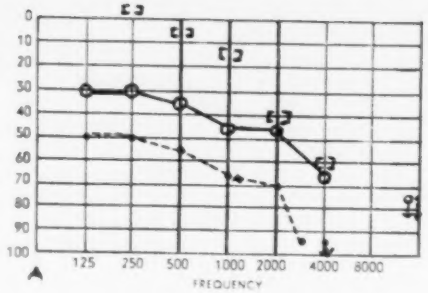
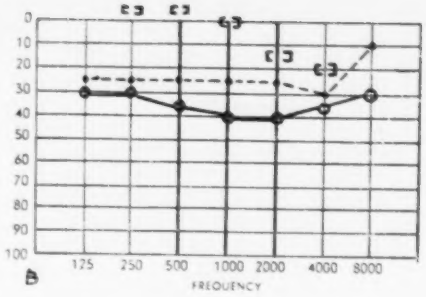
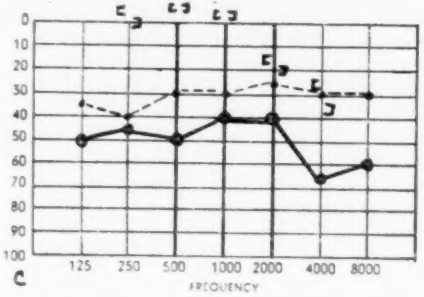
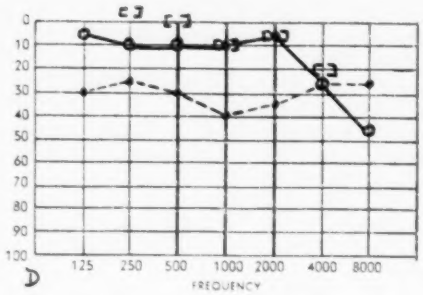
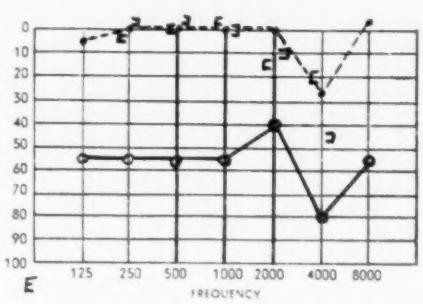


Fig. 1.—Audiograms of subjects in localization study. *A*, Case 1; *B*, Case 2; *C*, C, Case 3; *D*, Case 4; *E*, Case 5.









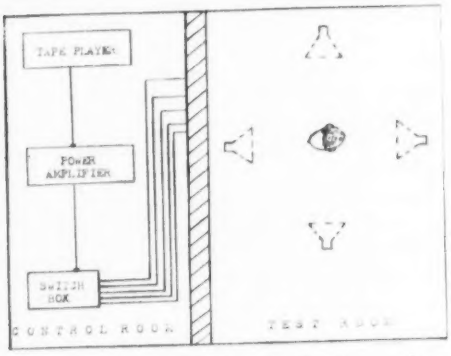


Fig. 2.—Equipment for localization study.

each presentation, the change of source being made after the subject made his determination. The first set of presentations was made at a level 10 db. above the sound field detection threshold, with each succeeding set going up in steps of 5 db.

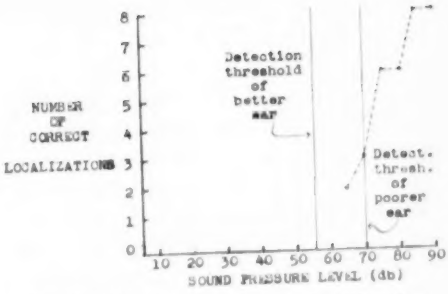

NUMBER OF CORRECT LOCALIZATIONS
Detection threshold of better ear
Detect. thresh. of poorer ear
SOUND PRESSURE LEVEL (db)

Fig. 3 (Case 1).—Localization of function.

Results.—It is apparent from these functions that the ability to localize in a person with a significantly better ear occurs when the level of sound is sufficient to stimulate the poorer ear as well. This is shown again on a scattergram, Figure 8, which includes

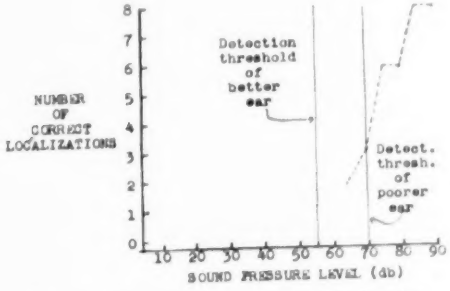

NUMBER OF CORRECT LOCALIZATIONS
Detection threshold of better ear
Detect. thresh. of poorer ear
SOUND PRESSURE LEVEL (db)

Fig. 4 (Case 2).—Localization of function.

The number of correct judgments was noted for each level of presentation, yielding a curve of "localization function." In Figures 3 to 7 localization function is shown for each of the five subjects. The detection thresholds of the better and poorer ears have been included to show the pertinent relationships.

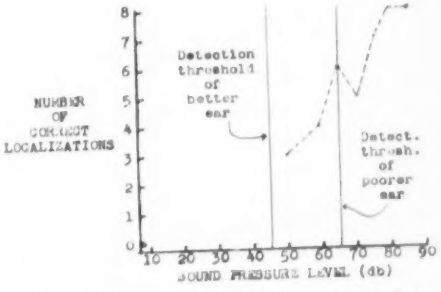

NUMBER OF CORRECT LOCALIZATIONS
Detection threshold of better ear
Detect. thresh. of poorer ear
SOUND PRESSURE LEVEL (db)

Fig. 5 (Case 3).—Localization of function.

the functions of the five cases, and which is plotted as a function of the sensation level of the sound at the poorer ear.

A study of the responses at low sensation levels showed that at these levels all sources tended to be judged as localizations at the

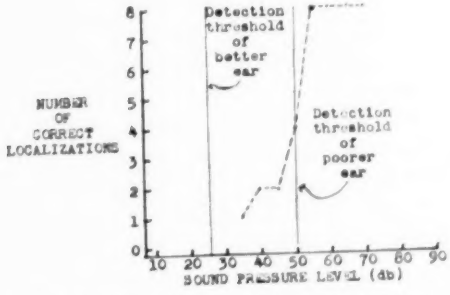

NUMBER OF CORRECT LOCALIZATIONS
Detection threshold of better ear
Detection threshold of poorer ear
SOUND PRESSURE LEVEL (db)

Fig. 6 (Case 4).—Localization of function.

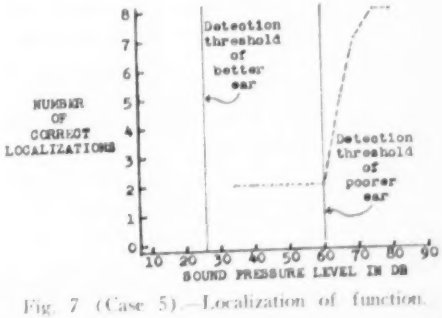

NUMBER OF CORRECT LOCALIZATIONS
Detection threshold of better ear
Detection threshold of poorer ear
SOUND PRESSURE LEVEL IN DB

Fig. 7 (Case 5).—Localization of function.

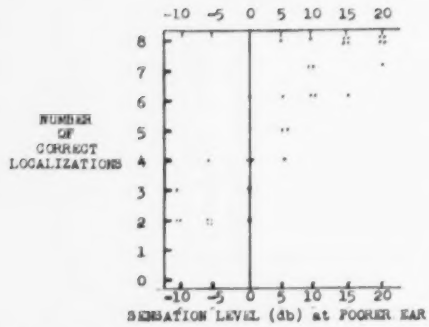


Fig. 8.—Scattergram showing the distribution of localizations of all subjects of the study as a function of the sensation level at the poorer ear.

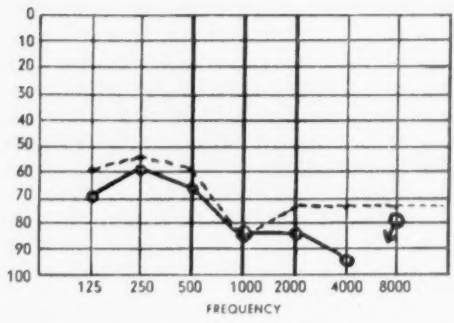


Fig. 9.—Audiogram of the blind patient. There was no response to bone conduction signals. The speech reception thresholds were as follows: right ear, 90 db.; left ear, 80 db. PB discrimination scores were as follows; right ear, 26%; left ear, 70%.

better ear or in front. An interesting report, made often, was that, while the sounds were consistently localized only to one point at the low sensation levels, they seemed to vary in loudness as they were shifted about the loudspeakers. This is similar to the usual experience of listening to monaural radio broadcasting.

Conclusions of Preliminary Study.—It is apparent from this brief investigation that localization, and very likely other aspects of binaural hearing, does occur in persons with ears which are markedly different from each other, provided the sound is above the audibility threshold of the poorer ear.

2. Selectivity

Selectivity is an aspect of binaural hearing which is apparently closely related to the ability to localize. In practice it is much more important to the hard of hearing than localization alone. It is concerned with the ability to listen to one signal, usually speech, while disregarding a competing signal, usually noise. It is thought that this is possible as the result of being able to separate the two sounds in space, through localization, although this is often accomplished without the listener's awareness of the process. The psychological mechanism of this function of audition was hinted at by Koenig, when he noted that, as his subjects were switched from a monaural to a binaural system, the background noises faded away only after a few seconds rather than instantaneously, and the subjects could continue to hear the noises if they so desired.

In connection with this aspect of binaural hearing I should like to report an experience with a subject who had blindness and a profound loss of hearing from the age of about 8 years to the present. She is now 24 years old. She had been using a hearing aid in her left ear since the age of 11.

Nearly three years ago, when she was a freshman at our college, I decided to try binaural hearing aids in her case in the hope of improving her discrimination of speech. On the day of the first attempt we started our regular auditory training period with the patient using her single instrument as usual. It was a warm spring day and the window of my office was open. She complained about the disturbing interference of noise coming into the room from across the street, where workmen were cleaning the facade of a stone building with blasts of sand. After some minutes of this the noise stopped while the workmen apparently rested. It was at this time, fortuitously, that I decided to introduce the second hearing aid. After both instruments were properly adjusted, the lesson was continued. Shortly thereafter the noise resumed, without complaint or apparent notice by the patient. At the end of the period I asked her to turn off and remove the second hearing aid. As

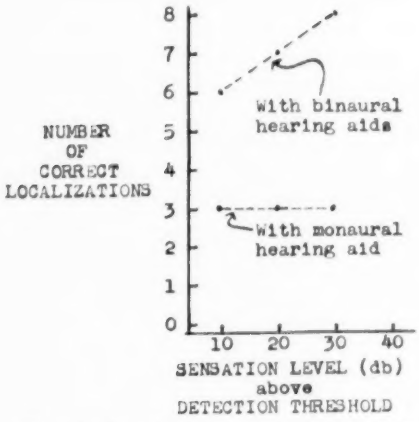


Fig. 10.—Localization function of the blind patient with a monaural hearing aid and with binaural hearing aids.

she turned this one off, leaving only her usual monaural arrangement, she looked up suddenly and explained, "Oh, there's that darned noise again!"

The same patient provided us with other interesting observations. Despite her lack of experience with binaural sound for so many years, she localized accurately with the binaural arrangement without practice or even a minimum period of learning.

She demonstrated that she could judge accurately not only the direction of sounds but their approximate distance as well, by walking along the college corridors for the first time without stumbling into groups of talking students. When tested she was able to walk up to a person who was speaking, turn her steps aside to bypass the speaker, then return to her intended course. With some instruction she quickly learned to turn her head in the direction of the speaker, replying directly to him, instead of staring ahead rigidly as she had done formerly.

3. Speech Discrimination

There has not yet been sufficient evidence accumulated to determine clearly whether binaural hearing results in significantly higher articulation scores in those who have poor speech discrimination monaurally. An interesting report was that of Bocca, who deliberately manipulated the presentation of speech in a different manner to each ear so as to achieve low monaural articulation scores, then presented the speech through the same systems binaurally.[5] He reported considerably improved articulation scores in the binaural presentation. Our own experiences with a small number of cases indicate that the articulation scores are indeed considerably better binaurally than monaurally, but it is felt that this must be more thoroughly investigated with a large number of hard of hearing subjects.

Of importance to the large group of hearing aid users who do not show discrimination losses when tested in quiet is the possible improvement binaurally in the condition of noise interference. Markle, in a preliminary report, demonstrated such improvement with hearing aids.[6] This is studied not with the conventional single loudspeaker which introduces both speech and noise, but with the speech coming from a source close to and in front of the listener and the noise occurring around the test area, simulating actual listening conditions.[7] It is probably better for the test area to be reverberant rather than sound-damped, again to approximate actual conditions, since, as Martin, Murphy, and Meyer found, reverberation tends to reduce articulation scores, particularly in cases of high frequency loss.[8]

4. Identification of Common Sounds

The ability to identify common sounds may not be considered essential but if it can be restored it would add another item of enrichment to the sensation of audition for the hard of hearing.

It has long been known that the characteristic quality of certain sounds is difficult if not impossible to reproduce convincingly through monaural systems such as conventional broadcasting. Preliminary studies on this aspect of hearing in the case of the blind patient indicated the apparent superiority of binaural hearing. Such studies must be carried out with live sounds for

identification since the use of single channel recordings would invalidate the test.

5. Ease of Listening

While it appears, from the reports of work by Hirsh and others, that there is only about a 3 to 6 db. improvement of hearing acuity binaurally,[1] clinical experience with users of binaural hearing aids indicates that less effort is required for comfortable listening when this system is used. A common observation is that binaural hearing aid users tend to turn up the gain of the remaining instrument considerably if one is turned off. A simple demonstration of the relative listening difficulty occurs when a normal listener alternately plugs up and releases one ear while listening to a speaker, particularly in a reverberant room. It is probable that this is related to the superior ability to squelch room reverberations when listening binaurally.

A problem for investigation is the difference in gain requirements when monaural and binaural instruments are used.

6. Quality of Sound

Moir reports that a stereophonic system with a band width of 3750 cps is as satisfying esthetically as a monaural system 15,000 cps wide.[9] If this is true of hearing aids, it would be a very happy thing for those hard of hearing persons who have lamented their inability to appreciate music as fully with a hearing aid as they once did before their loss of hearing.

Conclusion

The rapidly expanding clinical and experimental interest in binaural hearing demands bold new thinking for clinical application. The implications for the selection of cases and the evaluation of results associated with audiosurgery and for hearing aid guidance call for intensified investigation along many lines, some of which have been suggested in this paper. It is proposed here that some of the disturbing auditory difficulties still suffered by patients who have had improvement in the acuity of one ear through surgery or the use of a monaural hearing aid be studied to determine the possibilities of relief through the restoration of binaural hearing. It is apparent that a new battery of tests will have to be developed to quantify the advantages of binaural hearing. Some promising steps have already been taken, but adequate clinical evidence is still to be accumulated.

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Adjusting the Patient to the Hearing Aid

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The good audiologist or hearing aid consultant spends considerable time and effort in selecting and/or adjusting the hearing aid to the patient, but sometimes neglects a factor of equal or greater importance, i.e., the adjustment and conditioning of the patient to accept and utilize a hearing aid to the best advantage.

The patient is usually all pleased and excited at hearing loud noises where only muted or no noise has been heard for some time, and consequently he is inclined to be noncritical. It is very easy for the audiologist to go along with this spirit of optimism, if for no other reason than that it seems too bad to spoil the patient's illusion so soon. However, the patient is eventually going to learn that loud noises are not necessarily intelligible noises and may be very irritating. He is also going to learn that even a well-fitting ear mold is apt to be painful at first, and the weight of even the modern small aids may cause discomfort until the patient becomes accustomed thereto. All of these things are going to cause disillusionment and consequent dissatisfaction, which in many cases can be avoided or at least softened in their impact if the audiologist will do a realistic job of conditioning. The following items are suggested as being worth while for achieving some degree of preparatory conditioning.

1. Caution the patient not to expect a hearing aid to equal good unaided hearing. Such performance can be obtained but not in a unit small enough to be comfortably wearable.

2. Make him understand that a hearing aid is like a crutch; no one ever uses a crutch unless he has to. However, if a person cannot walk without one, he can eventually learn to tolerate the disadvantages and relatively poor performance of the device. The hearing aid falls into the crutch category, and it is important that the prospective user approach it with this in mind.

3. The ear is a creature of habit and likes best to hear what it is used to hearing. Thus the sounds heard through a hearing aid are not always pleasing at first, simply because they are different in some respect from the sound that the deafened ear has grown to consider normal. A person with a marked high-tone loss will have grown used to hearing the low frequencies apparently exaggerated, and, since most hearing aids do not respond well to the low tones, that person will feel that the sounds heard through the aid are thin and tinny. However, in the course of time, the new balance of high and low tones will become the normal and the old "normal" will sound dull and woolly with a poor value of intelligibility.

4. From Item 3 it will be apparent why the deafened person is not the one to decide which aid is best for him, since he is almost sure to pick the one which exaggerates his own frequency abnormalities, or else the one which sounds loudest. Neither of these criteria are likely to select an aid which will eventually provide the best speech intelligibility, and the patient should be made aware of this. If the frequency response of the hearing aid is adjustable to compensate for the patient's frequency loss,

Accepted for publication March 26, 1957.

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Supported in part by grants from the National Institute of Neurological Diseases and Blindness, the U. S. Public Health Service, and the Central Bureau of Research of the American Otological Society.

then such correction should be attempted only very slowly. Ideally the patient might grow accustomed to the aid without appreciable correction for a week or two and then return for a partial correction. Where more than 6 or 8 db. of correction is attempted at one time, the immediate result to the patient is almost sure to be unsatisfactory.*

5. The words which go to make up speech are simply sounds to which we have learned to attach certain meanings in an automatic subconscious manner. A new language involves learning a whole new set of sounds. Even after an adequate vocabulary has been learned, it still requires many months of actual practice to achieve the automatic subconscious interpretation of the new sounds necessary for one to be proficient in the new language. To a less extent this is true of the first use of a hearing aid; the word sounds are somewhat different from those the individual has become accustomed to.

Thus the rapid subconscious interpretation of speech meanings may require months of actual practice even when the cerebral centers which are responsible for this interpretation are intact. If these higher centers have become depressed, as they frequently do in old age, then the time and practice required for proficiency is increased still further; and many old people refuse to condition themselves, while at the same time complaining bitterly of the hearing aid deficiencies. A frank discussion of this factor with the patient may forestall much trouble for the audiologist and much disappointment for the patient. In any event it should be stressed that the required conditioning is a long-term affair and not something that can be achieved by a few minutes' or hours' practice with the audiologist.

6. Another element inherent in the hearing aid is the fact that the undistorted acoustic power which can be obtained from the average unit is far less than the overload capacity of the normal ear. Thus many noises which pass unnoticed by the normal ear become unpleasant when heard through the hearing aid, owing to overloading of the aid. Impact noises such as slammed doors, the clatter of cutlery in a dining room, and similar noises can be most unpleasant until the patient becomes accustomed to them in the new (and sometimes distorted) form. This condition is further exaggerated by the fact that the deafened ear has heard such noises only dimly, if at all, for a long time. Thus they can be annoying even if not distorted. As earlier stated, it is possible to build a hearing aid which will not overload so easily, but the weight and bulk involved are more than most people will accept.

In the presence of high background noise such as that encountered in trains, planes, and cocktail parties, the hearing aid may be overloaded all the time, so that speech intelligibility is practically nil. The patient should be instructed to reduce the hearing aid gain, under such conditions, until speech comes through with reasonable clarity. The wearer of the hearing aid may then be delighted to discover that he hears close-up conversation better than people with normal ears when he finds the right gain adjustment for a particular noisy location. This is not true of all types of deafness, but is always worth trying.

7. Another factor which should be recognized, has to do with the monaural effect inherent in a single hearing aid. Listening with one ear only reduces the directional discrimination even with a normal ear, and the microphones of most hearing aids are essentially nondirectional anyway. Thus the patient must be cautioned that he will usually not be able to locate the source of sounds except visually. Another disadvantage of monaural sound pickup appears in connection with the acoustics of rooms or

* The question as to whether an aid should be chosen to compensate for the wearer's frequency abnormalities is still debated, but the abnormalities should certainly not be reinforced. One or more bad resonant peaks in the hearing aid response may produce an effect of loudness but degrade the speech intelligibility.

buildings, and the effect thereof on the patient. Rooms with any noticeable amount of reverberation seriously reduce the intelligibility obtainable through an aid, owing to a combination of two factors: (*a*) the monaural effect and (*b*) the limited overload capacity of the aid as noted in Item 6. A pure tone in a reverberant room will set up so-called standing waves where reflection of the tone from the walls tends to cancel or reinforce the original sound in some particular pattern; when the frequency of the tone changes, so also does the position of these peaks and valleys of sound intensity, and thus, when the frequency changes continuously as in speech or music, these peaks and troughs fairly fly about the room. With normal binaural hearing this causes little trouble since the peaks and valleys do not strike both ears at the same time, and the ear is unlikely to be overloaded anyway. The microphone of the hearing aid, however, is a single point of pickup, and, if the gain is adjusted so that the high-intensity values do not overload, then in some cases the low-intensity portions may be too low, or vice versa. Thus intelligibility is likely to be very poor. This is the reason why a hearing aid is frequently not satisfactory in theaters or auditoriums, especially if the normally required gain is high and thus close to the overload level of the aid under average conditions. The use of two hearing aids can provide binaural hearing and eliminate many of the acoustic disadvantages of a single unit, but few people are willing to go to the expense of two aids or to be bothered by such a double feature. The increase in apparent sound level obtained by binaural hearing is too small to be of consequence, but the improvement in speech intelligibility and perception may be very important for some people.

8. Clothes' noise is frequently a source of annoyance and is sure to occur to a greater or less extent whenever the microphone is concealed under clothing. For women the smaller hearing aids can be concealed in the hair, and this location is probably optimum in most respects. The eyeglass or ear mounted types seldom fool anyone as far as concealment goes, but provide men as well as women with a good location free from clothes noise and without external cords. The wearer can become conditioned to clothes noise, but it is always unpleasant and has a masking effect which can reduce intelligibility. There is also some loss in high-frequency response which may be needed in many cases. Advise the patient as to the best location for the aid, considering all the factors involved (and appearance and the patient's vanity cannot be ignored), stating the reasons therefor. Regardless of whether the patient accepts such advice, he or she should get used to the aid in one place and keep it there.

Reverting momentarily to the type of hearing aid mounted in the bows of eyeglasses, there are some factors which should be recognized with respect to this type of unit. As noted above, the elimination of clothes' noise is a very important item; however, hearing aids which can be so mounted are of necessity small in size and limited in power-handling capacity. Thus they are useful only for those persons with "moderate" hearing loss (about 50 db.). There are, however, some undesirable features in this type of unit, one of which is its susceptibility to wind noise, since the microphone is exposed. For those who may be functioning in windy locations this characteristic might be even more undesirable than clothes' noise. Many makes of these units are mounted in solid box-like eyeglass bows which do not lend themselves to being bent and modeled to the wearer's head. Since the weight of the eyeglasses is considerably increased, it is very desirable that the bows be made to fit exactly, for optical performance as well as for the wearer's comfort. Those patients who may consider this type of unit should be warned that adjustment of the frames may be necessary over a period of several weeks to

avoid discomfort while maintaining optical alignment.

9. One of the most difficult problems for an audiologist to deal with is the patient with considerable loss who also has recruitment. The margin between the volume level necessary to reach the patient's S. R. T., and the level at which cochlear overloading takes place is sometimes so small that extra attention must be paid to both the selection of an aid and instruction in its use.† Patients in this category are not usually as much concerned with appearance as they are with intelligible communication and so can be advised not to wear the aid underneath clothing at any time. They should also be instructed to use the volume control freely. Different voices not only vary widely in level, but the sound level of a single voice may vary by 15 or 20 db. Furthermore, sound power varies as the square of the distance from the source, so that the difference between standing 2 ft. or 5 ft. from a speaker is considerable. In some cases the lower values of speech might be below the acceptable threshold at 5 ft. while the higher levels would overload the ear at 2 ft. Thus the volume control of the aid must sometimes be adjusted to maintain the level within the patient's narrow tolerance area even when talking to the same person.‡ Two receivers from the same aid are said to improve the intelligibility somewhat, and two separate aids are almost certain to provide marked improvement if the patient will accept the added expense and annoyance of a second unit. The patient, however, must be made to understand the nature of his condition or he will blame the hearing aid for his lack of communication, and will never learn to operate it to the best advantage.

10. Presbyacusia calls for the same kind of hearing aid selection as suggested for cases of recruitment. This is necessary for two reasons: (*a*) Recruitment is sometimes present with presbyacusia, and (*b*) older people are apt to be less tolerant of aid distortion than younger people because they are conditioned by many years of experience to their own "normal" and are apt to be a bit testy about conditioning themselves to anything different. These older people are the ones who most need the advice of the audiologist, even though they frequently refuse to accept it. However, such advice is much more effective if given to the patient before he attempts to use an aid than it is after he returns complaining about it. Outside of purely mechanical things, such as forgetting how to turn the unit on or off and similar difficulties, the complaints are usually as follows: "I can't wear it for long because it makes me nervous," or, "It makes voices real loud, but I can't understand." Both complaints are combined sometimes. The first complaint is frequently due to bad resonant peaks in the hearing-aid response, which, as noted, should be avoided as far as possible. If the aid has been properly selected, the second complaint may be due to failure of rapid interpretation at the cerebral centers. Considerable diplomacy is called for in this case, since the patient must be made to realize that the trouble is within himself and not the hearing aid. Once this has been achieved, the patient may then be persuaded to ask people to speak more slowly. If this is done and if the patient is instructed to keep the gain down to a minimum, the intelligibility may be good enough so that the aid will be worn more than occasionally. Since slow functioning of the higher centers can be the chief factor in low intelligibility in these cases, it will be apparent that listening and interpreting experience is even more important in cases of presbyacusia than in any other form of deafness. Unfortunately the elderly patient is the least likely to wear an aid constantly enough to

† A hearing aid for this condition should be essentially free from resonant peaks in response characteristic, and should have an above average output power rating to avoid, as far as possible, any distortion due to overload within the hearing aid.

‡ Some new aids provide automatic volume limiting which can be helpful in many cases.

learn the "language." However, if the audiologist gives the patient the whole story, there will be some who will practice what has been preached, and profit thereby.

11. The size of the hearing aid is not necessarily a measure of its performance and value. However a unit with an acoustic output power capacity of 145 db., relative to acoustic zero, is bound to be a lot bigger than one rated at 135 db. because the undistorted power output is 10 times as great. This should be explained to the patient when a powerful unit is made necessary as in Item 8 or 9. In general, the larger a battery for a given job, the more economical such a unit will be. Battery capacity increases very sharply with increased size.

12. Perhaps the most important thing about which to warn a patient is the fact that the hearing aid is an electromechanical device which is almost certain to encounter failures of various kinds.

The chief causes of these failures are battery exhaustion and cord trouble. Older people in particular should be warned that probably 75% of the trouble they will encounter will be due to battery exhaustion and a great deal of this will be due to leaving the aid turned on after it has been taken off for the night or put away for perhaps a day at a time. The only safe way to avoid this human failing is to remove the battery from the aid when it is not in use. It should not be necessary to point out to the patient that a supply of batteries ought to be kept on hand at all times, but it might be worth suggesting that when the aid fails to function as it should, the first step should be to replace the battery with one which is known to be new and unused. Where cords are used in connection with the hearing aid, it is very desirable that the patient have at least one spare cord with which he can replace an existing cord if at any time he is plagued by uncertain and scratchy response. Even with the above factors considered, it is still unfortunately true that over a period of time the aid is almost certain to develop other defects which must be remedied by the service organization of the aid manufacturer. However, the intelligent patient can avoid a great deal of trouble by the foregoing warning as to battery and cord troubles.

Conclusion

A prospective hearing aid user is more likely to adjust well and quickly if he is given information on the bad as well as the good features of the aid as applied to his specific case. The audiologist can do far more good by preparing the patient psychologically for the "breaking in" period than by attempts to condition him by means of artificial noise or similar artifices in contrived situations. Even where such conditions bear some relation to reality, they are too short in duration to have much value. Rapid, automatic, subconscious interpretation of the partially new language heard through a hearing aid can be achieved only by months of constant use under real conditions. The audiologist can, however, render real assistance as an adviser and counselor during this difficult period.

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Effect of Masking on Induced Conduction Deafness

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It has been demonstrated that masking with 80 db. of white noise re normal threshold (95 db. re 0.0002 dyne per square centimeter) can for clinical purposes eliminate a normal hearing ear while testing the opposite ear by bone conduction. With this degree of masking there is no significant overmask.[1] It is frequently necessary to use masking in an ear which has some degree of conduction deafness. There is no experimentally confirmed knowledge of the degree of masking necessary in such an ear or the effectiveness of usually employed intensities in various degrees of conduction deafness. The object of this study is to determine the difference in response to masking of a normal ear and of one with experimentally induced conduction deafness as measured by crossed bone conduction.

Material and Method

For the purposes of this investigation 20 subjects with unilateral complete deafness were selected. This degree of deafness was confirmed by various tests, including the complete absence of air conduction or hearing near the limits of the audiometer at the lower frequencies when the good ear was masked with white noise at 80 db. re normal threshold. It was felt that by studying cases with one completely deafened ear all bone conduction measured at such an ear must be crossed hearing, and the effectiveness of masking the opposite ear could then readily be evaluated.

The instruments used for hearing testing were calibrated Peters (Sonotone #23) and Audivox audiometers, whose masking tones were calibrated on an artificial ear.*

Hearing tests were performed in the following manner:

1. Air conduction without masking
2. Air conduction with 80 db. mask in good ear
3. Bone conduction without masking
4. Bone conduction with 80 db. mask in good ear
5. Air conduction with Flent in good ear and no mask
6. Bone conduction at mastoid of deaf ear with Flent in good ear and 80 db. mask in good ear.

The spectra of the noises used for masking are shown in Figure 1. Varying degrees of conduction-hearing impairment were induced in the good ears by inserting wax plugs (Flents) into the external auditory canals. Figure 2 shows an example of the data collected on one of the subjects.

Results

The results obtained in 20 subjects are shown in Figure 3. For each subject at each frequency tested there is plotted on the abscissa the change in air conduction produced at the good ear with Flent occlusion. The ordinate shows the change in bone conduction recorded at the deaf ear with the same amount of mask (80 db.) before and after insertion of Flents in the good ear. From this Figure, there seems to be little correlation between the degree of change in effect of masking and the degree of conduction deafness. It is apparent that practically the same degree of change in bone conduction was produced in subjects who had as little as 5 db. of induced deafness as in those who had as much as 30 db. This impression was confirmed by a rank correlation analysis.

Received for publication Feb. 21, 1957.

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* The masking intensity (95 db. re 0.0002 dyne per square centimeter) was checked on a Kellogg artificial ear and corresponded to a dial setting of 60 on the Audivox and of 80 on the Peters audiometer. Unless otherwise specified, masking intensity expressed in this article is re normal threshold (15 db. is added to convert to 0.0002 dyne per square centimeter). Since only the changes in bone conduction were used in this study, actual readings of bone conduction without correction were recorded.

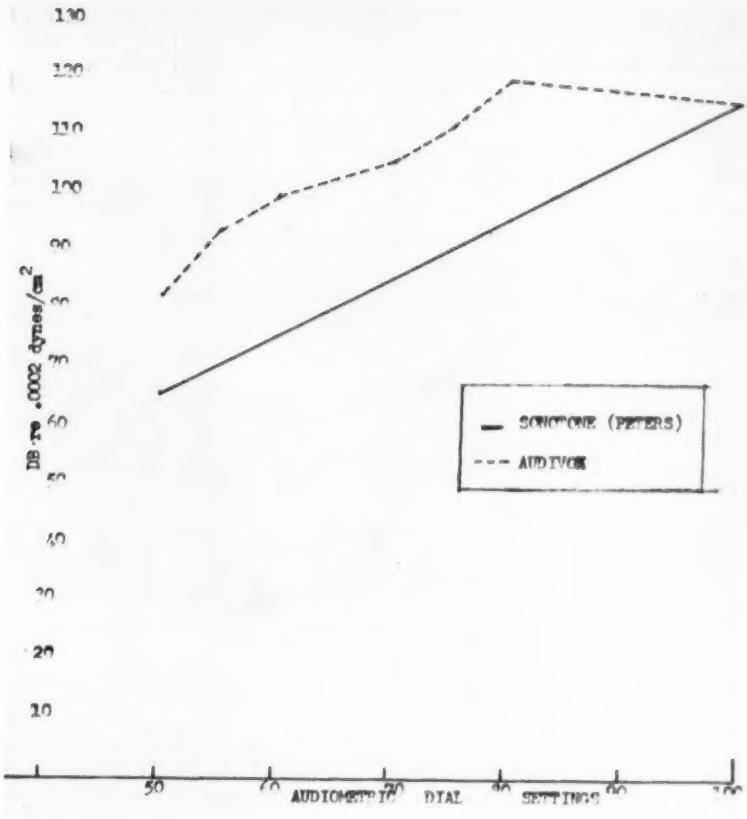

Figure 1

JEFFERSON HOSPITAL
HEARING RECORD

Referred By W. Neuro.

NAME [redacted] AGE 42

ADDRESS

AIR CONDUCTION

DATE	RIGHT 125	250	500	1000	2000	4000	8000	LEFT 125	250	500	1000	2000	4000	8000	EXAM.
		55	45	40	40	70	60	P	5	-5	-10	-10	-5	0	
		85	100	105	100	95	90		MASKED AT 80						
		WITH FLENT A. S.							25	25	20	20	30	35	

BONE CONDUCTION

DATE	RIGHT 250	500	1000	2000	4000	OPP EAR MASKED LEVEL	TYPE	LEFT 250	500	1000	2000	4000	EXAM.
	25	15	5	10	35	NO	MASK	20	20	20	5	20	
	35	60	75	75	70	80	WN						
	5	30	30	45	50	80	WN	and FLENT IN A. S.					

SPEECH RECEPTION

DATE	RIGHT	LEFT	FREE FIELD	MAT'L	MIC	REC	EXAM.

HEARING AID

DATE	MAKE	EAR	MFL	MIC	REC	EXAM
	MODEL					
	GAIN					
	DISCRIM					

Figure 2

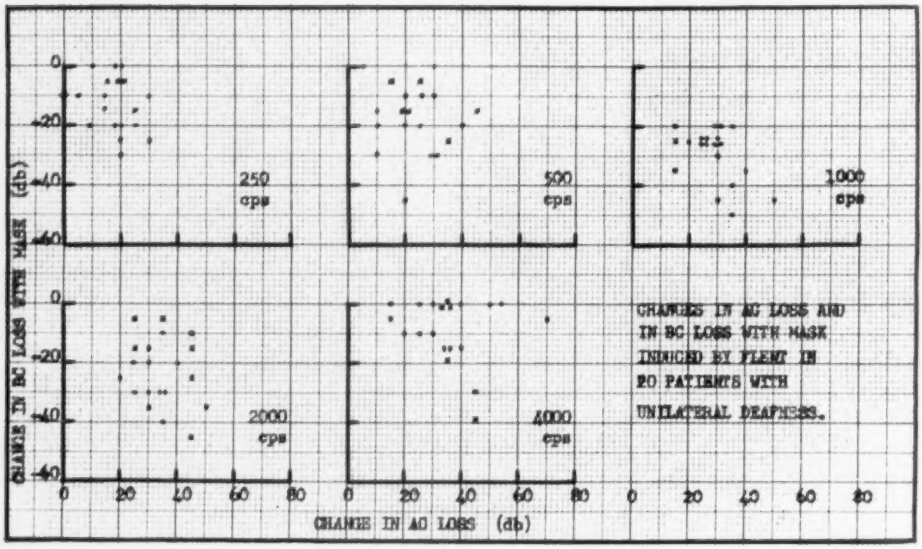

Figure 3

It is interesting to note that at 250 cycles the Flents produced no marked hearing loss in air conduction in two of the subjects. Nevertheless, and quite consistently, there was a prominent decrease in bone-conduction loss despite the insignificant change in air-conduction loss. The irregular changes at 4000 cycles also deserve comment. Even though the changes in air conduction were considerable, almost half of the subjects showed no change in bone conduction with masking. In each of these instances the ear was "out," within the limits of the audiometer, both with and without the Flent. Any change that may have been present could, therefore, not be measured with the equipment used. It is also evident from Figure 3 that at 4000 cycles, and to a less marked degree at 500 and 2000 cycles, the change in bone conduction due to Flent occlusion with masking was rather consistently smaller than the air-conduction change.

While occlusion with Flents simulates the condition resulting from impacted cerumen, findings under such conditions do not necessarily apply to the hearing loss produced by fluid in the middle ear or by otosclerosis. The fact that a wax plug produces a resonating chamber in the external auditory canal is at least one feature distinguishing it from the hearing loss found in involvement within the middle ear.

On the basis of a priori reasoning it would appear that a linear relationship should exist between the degree of conduction deafness and the amount of effective masking required. Thus, if 80 db. of mask is effective for a normal ear, a conduction-deafened ear with a 20 db. loss should require 100 db.; with a 30 db. loss, 110 db., etc. In the present experiment, in which the masking noise was kept constant but the degree of conduction deafness varied, there was no evidence of such a linear relationship or of any relationship at all.

Figure 2 demonstrates the difficulty in satisfactorily masking out an ear with conduction deafness. While the present study clearly shows that 80 db. of masking is inadequate to eliminate a conduction-deafened ear, the lack of correlation raises some interesting questions requiring further investigation. A wax plug may change position during testing, resulting in a fluctuating degree of hearing loss. The fit of a wax plug in the cartilaginous part of the auditory

canal may also produce varying types of resonating cavities in different ears, resulting in different and unpredictable resonant and attenuating characteristics. It is also possible that the wax may have an attenuating effect at low intensities differing from that at higher intensities, in addition to the well-known greater effect on high frequencies. The attenuating effect of a wax plug was measured at threshold to determine the degree of conduction deafness while the mask was applied at 80 db.

From the results obtained in this experiment in 20 cases of unilateral deafness, in which we determined the effectiveness of 80 db. of masking in induced conduction-hearing loss, the following conclusions are suggested: 1. Eighty decibels re normal threshold of white-noise masking is inadequate to eliminate a conduction-deafened ear while testing the opposite ear by bone conduction. 2. There seems to be little correlation between the change in effective masking and the degree of conduction deafness artificially induced with a wax plug in the external auditory canal. 3. In this type of deafness, even a small impairment will require a well-marked increase in masking intensity if the ear is to be masked out. Until such time as either a more effective application or type of masking sound is used, clinicians should be aware of the limitations of masking a conductively deafened ear.

The statistical analysis was performed by Hyman Menduke, Ph.D., Department of Biostatistics, Jefferson Medical College.

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Case Reports

Two Case Reports of Embryonal Rhabdomyosarcoma with Primary Presentation in the Ear

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Introduction

The primary purpose of this paper is to alert otolaryngologists to embryonal rhabdomyosarcoma, a disease which occurs in childhood and which is insidious in onset. It is extremely serious if not discovered and treated very early in its course. Embryonal rhabdomyosarcoma, under the name of sarcoma botryoides, was once thought to be limited to the pelvic region. With more advanced techniques, however, pathologists have been able to show that this type of tumor occurs also in the head and in the neck.[1,2]

Three important facts about embryonal rhabdomyosarcoma have a direct bearing on differential diagnoses of tumors of the head and neck in children, namely, (1) the disease occurs most frequently in childhood between the ages of 1 and 6 years; (2) the primary presentation is usually a tumor, and (3) the common sites of occurrence are in the region of the auricle, the orbit, the nasopharynx, and the palate.

We wish to point out particularly that adequate amounts of biopsy tissue must be supplied to the pathologist if a proper diagnosis is to be made. Careful examination of the tissue by special techniques is frequently necessary.

General Description of the Disease

Occurrence.—Embryonal rhabdomyosarcoma of the head occurs most commonly in children between the ages of 1 and 6 years.[1,3] Unfortunately, this age group is frequently neglected in pediatric oncology[3-5]; the postnatal examination of the first year is over, and preschool children do not have the benefit of the over-all supervision generally provided for the school child. Consequently the small, seemingly insignificant symptoms are passed over, largely because they resemble the results of numerous episodes of trauma to which children in this age group are exposed.

Symptoms.—The primary manifestation is swelling located in the postauricular region or in the ear canal. The enlargement or mass usually grows very rapidly. Even though it is first noted as a small insignificant soft prominence, it may have grown to an alarming degree before the next observation. The absence of pain, Nature's usual danger signal, may explain why the tumor frequently progresses rapidly to an extensive degree without causing alarm. The importance of the physician's awareness of the absence of pain and discomfort in this condition cannot be overemphasized. Absence of warning is probably mainly responsible for the progression of the disease to an advanced stage before it is discovered.

The symptoms are discharge from the ear; hearing loss (which is disregarded by young patients because it is unilateral); facial paralysis, which appears early in the progressive destruction of the contents of the middle ear, and finally vertigo, a relatively late symptom which follows facial paralysis.

Accepted for publication April 21, 1957.

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Physical Findings.—The presenting tumor is a soft, fluctuant, well-localized mass. The presence of a compressed or drooping ear canal and a granular polyp are apt to belie the true nature of the disease. The granular mass in the ear canal frequently has the appearance of a typical "aural polyp." Local metastasis is an early sign of the disease. Lymph-node enlargement in this region is also usually suggestive.

Pathology.—The pathologist who examines the biopsy tissue must be aware of the possible existence of embryonal rhabdomyosarcoma. Special stains are necessary to demonstrate the striae in muscle tissue in this tumor, and these stains are sometimes needed for a definite final diagnosis.

The microscopic picture of the tumor is usually typical of a mixed-type tumor with a profusion of small, medium, and large spindle cells. An occasional striated muscle cell of abnormally distorted shape is present. The characteristic cell types, then, are the predominant spindle cells plus an occasional large racquet-shaped embryonal striated muscle cell. Because of the sparseness of their occurrence the striated muscle cells are frequently difficult to locate. As a matter of fact, the spindle-cell sarcomatous type of tissue may predominate to such a degree that it obscures the true diagnosis.

For a specific description and discussion of the pathological techniques of evaluating this tumor, the reader is referred to the article by Stobbe and Dargeon,[1] and the new "Atlas of Otolaryngic Pathology" of the Armed Services Institute of Pathology.[6]

Report of Cases

Case 1.—The first case report is that of a 3-year-old child whose mother discovered a painless mass behind the right ear in July, 1952. The mass was approximately 1½ in. in diameter and was, for about six months prior to its discovery, associated with a hyperirritable personality. One month later a bloody drainage from the ear indicated a granular tumor. Pathological examination of this tissue indicated it to be granulation tissue of chronic infection. X-rays of the mastoid region at the time of discovery showed no evidence of bony involvement.

Late in August a subauricular lymph node enlargement was noted. Investigation of this enlargement led to an exploratory operation with biopsy of the mass behind the ear and of the lymph nodes in the neck. Examination of the tissue from these biopsies led to a report of embryonal sarcomatous malignant tumor. At that time a complete general physical examination was given, including intravenous pyelogram, barium enema, gastrointestinal series, and x-rays of the skull. All reports were negative.

On the basis of pathological findings of an embryonal sarcomatous diagnosis, the patient received some 9000 units of x-ray therapy distributed over the right base of the skull, right temporal area, and left temporal area. This program succeeded in eradicating the clinical evidence of disease for the next three months.

There was no gross disturbance of the child's normal development until February, 1953, at which time she began to complain of stomach cramps. It was noted then that she had a low hemoglobin value. Examination by x-ray revealed the presence of one "spot" on the skull and of another on the right upper lobe of the lung. A palliative dose of x-ray therapy was directed to the lesion in the lung. Supportive therapy in the form of repeated transfusions was carried out, but the child died of widespread metastasis in April, 1953. The autopsy protocol noted the presence of lesions in the upper left lobe of the lung; multiple sites in the perigastric and mesenteric lymph nodes were discovered; a large tumor was noted in the wall of the stomach. As there was no report of examination of the head, one must assume this area was not investigated. The clinical course of the disease and the results of the biopsies suggest conclusively, however, that the head was the primary source of the disease.

Case 2.—The second case report is that of a 3-year-old boy who was discovered to have a painless swelling and prominence of the left ear after a haircut in August, 1953. The swelling enlarged very rapidly and within the next three weeks the facial nerve had become paralyzed. Examination of the ear canal revealed the typical "drooping of mastoiditis" and collapse of the ear canal. Examination of the mastoid and right temporal area by x-ray showed a large radiolucent defect in the squamous and petrous portion of the temporal bone. On Sept. 9, an exploratory operation and biopsy was carried out. It corroborated the x-ray findings, indicating that the tumor had extensively invaded the dural plate and the dura, and had infiltrated the structures of the middle ear, including the facial nerve.

Examination of frozen sections of the biopsy tissue suggested the presence of a fibrosarcomatous tumor. On examination of the paraffin sections of

the lesion, however, the pathologist changed the diagnosis to embryonal rhabdomyosarcoma. On Sept. 21, 1955, an extensive excision of the tumor was carried out. The operation revealed the presence of suspicious tissue in the area of the foramen magnum. As a follow-up of surgery the tumor was treated by high-voltage x-ray radiation.

In December, 1955, the metastasis had extended to involve the femurs bilaterally, the pelvic girdle, and the shoulder girdle. Pulmonary lesions of the chest were noted on x-ray examination. At that time a program of nitrogen mustard therapy, as a form of chemotherapy, was carried out to control the peripheral metastasis. There was a limited response to this therapy but, at the completion of the program there was recurrence at the site of the primary lesion. In spite of extensive efforts in the form of surgery, x-ray therapy, and chemotherapy, there was no apparent means of controlling the extension and growth of the tumor, which progressed and resulted in the death of the patient.

It is interesting to note the similarity of symptomatology that occurred in both these patients: other than a general tendency to hyperirritability, there was a dramatic lack of discomfort in spite of the extensive local and peripheral growth of these tumors.

Comment

Embryonal rhabdomyosarcoma frequently presents itself as a painless enlargement in the axis of the Eustachian tube or the first branchial pouch and cleft. It may be associated with a drainage from the ear similar to a chronic otitis media, although the appearance of a polypoid type of tumor in the auditory canal is frequently considered in a differential diagnosis to be due primarily to chronic infection. The orbit has been a frequent site of occurrence of the lesion, apparently primarily from orbital muscle. Embryonal rhabdomyosarcoma must be considered in any differential diagnosis of a painless tumor associated with a large lytic lesion in the adjacent bony structure of the head.

In a review of the literature we found two cases of embryonal rhabdomyosarcoma which responded to therapy. They were localized lesions which were removed from the palate and from the orbit. Removal of the lesion has resulted in satisfactory cure of the condition only when its primary size was less than approximately 2 cm. in diameter.

It follows that small lesions in any of the areas we have mentioned specifically merit immediate biopsy, particularly for preschool children.

The treatment of embryonal rhabdomyosarcoma is limited in most instances to palliative x-ray therapy with high gamma percentage radiation.

The prognosis of a painless tumor with a diagnosis of embryonal rhabdomyosarcoma is poor.

Conclusions

The two case reports suggest that embryonal rhabdomyosarcoma is a disease which occurs in the axis of the first branchial arch and may present itself as a primary tumor in the region of the ear. Successful treatment of this condition suggests radical emergent consideration of tumors in the region of the ear and immediate biopsy.

Summary

The clinical picture of embryonal rhabdomyosarcoma emphasizes the necessity of an adequate biopsy of any granulomatous lesion of the ear canal, particularly if it is associated with swelling behind, above, or in front of the ear. Other areas particularly prone to this disease are the soft palate and the orbit. The reported progression of tumors from a primary source in the ear, the nasopharynx, or in the palate, has been through the axis of the Eustachian tube or first branchial arch.

Embryonal rhabdomyosarcoma must be considered in any differential diagnosis of a painless tumor associated with a lytic lesion in the adjacent bony structure of the head.

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Successful Cardiac Resuscitation Following Tetracaine Reaction

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Severe toxic reactions and fatalities following the use of tetracaine have repeatedly been reported in the literature, and analysis of these reports reveals that practically all of these reactions have occurred after topical application and few, if any, after subcutaneous infiltration or other forms of regional anesthesia (Bonica[1]).

Following the topical application of tetracaine, there is rapid absorption into the circulation, and blood levels are attained that are equal to one-third to one-half those that occur after the same amount of the drug has been rapidly injected intravenously. After the subcutaneous injection of the same dose of tetracaine the blood level is so low that it is unobtainable. These blood level studies were done on dogs by Adriani and Campbell.[2] After application of tetracaine to mucous surfaces of the pharynx, larynx, and bronchi peak blood levels were reached within four to six minutes. There was little difference between the levels after application to the pharynx and to the trachea. Epinephrine added to the tetracaine solution did not retard absorption. These authors also showed that identical blood levels were obtained when the total dose, in milligrams, remained constant but the concentration was varied from 2% to 4%. Thus the blood level was proved to be a function of total dosage and not of concentration, and the blood levels closely simulate those obtained after rapid intravenous injection.

A distinguishing characteristic of tetracaine when used as a topical anesthetic agent is that when a severe reaction due to overdosage does occur it is usually atypical one (Moore[3]). The reaction is usually not heralded by restlessness, nervousness, dizziness, sweating, pallor, or tachycardia. There is no such convenient warning. It frequently is abrupt in onset; convulsions are absent, and syncope and circulatory collapse are the usual events.

Submitted for publication May 9, 1957.
From Butterworth Hospital.

Report of Case

An 85-year-old white man was admitted to Butterworth Hospital on May 25, 1956, because of hoarseness. The history revealed the onset of painless hoarseness in 1946, at which time a suspension laryngoscopy and excision biopsy of benign squamous-cell papillomata of the vocal cords was done. After the first operation, he had seven subsequent hospitalizations for excision of recurrent tissue, at intervals of from four months to two years. The anesthesia for these procedures was accomplished by topical application of cocaine and tetracaine, supplemented in the last three operations with intravenous barbiturate, nitrous oxide-oxygen, and relaxant. No unusual complications were noted.

The remainder of the past history was noncontributory except for an episode of syncope six years prior to admission, when he fainted while climbing stairs and was admitted to the hospital for a cardiac work-up. The EKG was normal, and no evidence of heart disease was found; otherwise the patient had enjoyed excellent health.

Physical examination at the time of admission showed a well-developed, well-nourished man; height 5 ft. 10 in. (177.8 cm.); weight 190 lb. (85.5 kg.). Temperature was normal. Blood pressure 144/88; pulse 84; respirations 16. His voice was hoarse, but there was no associated respiratory distress; the heart and lungs were negative.

Laboratory tests revealed Hgb 13.0 gm. per 100 cc.; hematocrit 43%; urinalysis negative; Kahn reaction negative.

On the morning after admission, morphine sulfate, 10 mg., and scopolamine bromide, 0.3 mg., were given subcutaneously one hour before operation. Blood pressure was 150/80 and pulse 80, and

the patient was awake and relaxed at the start of anesthesia. The surgeon sprayed the nasopharynx with 5% cocaine. Topical anesthesia was achieved by application of 2% tetracaine (Pontocaine) hydrochloride to the pharynx and pyriform fossae, an estimated 5 cc. being used. Pentobarbital (Nembutal) sodium, 2 grains (0.12 gm.) was given intravenously, followed by 30 mg. of gallamine (Flaxedil) triethiodide, and an oropharyngeal airway was easily inserted. He was then given 100% oxygen by mask and was breathing well. Three minutes later, or approximately five minutes following the last application of tetracaine, the anesthetist, who was checking the pulse at that moment, noted sudden stopping of the radial pulse. This occurred just as the surgeon was starting to insert his laryngoscope but before the larynx had been exposed. There was no slowing of the pulse prior to the cardiac arrest; and after the pulse had stopped, the patient gasped three times. The patient was pale but not cyanotic. The time was noted. The surgeon was informed of the probability of cardiac arrest. The anesthetist inserted an endotracheal tube and inflated the lungs with oxygen, and in a few seconds another physician was summoned by the circulating nurse to help the surgeon. This other physician immediately performed a left thoracotomy between the third and fourth ribs. No bleeding was encountered. The heart was noted to be in asystole by palpation. Further exposure was obtained by dividing the costal cartilages of the third and fourth ribs. Then the heart was manually compressed five to six times through the intact pericardium, and the heart began beating spontaneously.

The heart began beating forcefully and regularly, so that a blood pressure was obtained at 180/100, with a regular pulse of 90. The time from the onset of the cardiac arrest to the reinstitution of circulation was only 75 seconds.

Thereafter, the heart continued to beat regularly and forcefully; the blood pressure ranged between 160/90 and 140/80, with a pulse of 90. After only a few minutes of artificial respiration (by oral endotracheal tube-bag compression), spontaneous and adequate respiration began.

The chest incision was then closed with water-seal drainage. A tracheotomy was performed before the endotracheal tube was removed. During the tracheotomy ether was added to the oxygen because the patient was struggling and moving. The patient had responded completely that same afternoon, and there was no subsequent indication of mental impairment.

Postoperatively, the course was similar to that of any thoracotomy, the only complication being a minimal basilar pneumonitis and left pleural effusion. An EKG on June 1 (six days postoperatively) showed a first-degree AV block, an old healed posterior myocardial infarct, nonspecific myocardial changes, and premature auricular contractions.

He was discharged from the hospital on June 8, or 13 days after the cardiac arrest.

He was readmitted on June 30, and a suspension laryngoscopy and excision of laryngeal papillomata was done after topical anesthesia with 2% hexylcaine (Cyclaine) hydrochloride, the patient having received morphine sulfate 10 mg., scopolamine hydrobromide 0.4 mg., and pentobarbital hydrochloride 100 mg. one hour preoperatively. This operation was uneventful.

Three weeks later the tracheotomy tube was removed. He has done well since.

Conclusion

Fatalities due to tetracaine when used as a topical anesthetic can be prevented not by giving a preanesthetic dose of a barbiturate but by avoiding overdosage.

It is the opinion of most authorities that a top dose of 40 mg.—and certainly not more than 50 mg.—should not be exceeded. This regulation may best be done by putting no more than the measured top dose into the medicine glass, so that there is no chance for error. Furthermore, a solution of 0.5%–0.25% can be used and will give adequate anesthesia, so that the volume will be larger without increasing the dose (Carabelli [4]).

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A Simple Caloric Test

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There are many caloric tests; some are simple, some are complex. They vary in accuracy and in the amount of information obtainable. We are all familiar with most of these. There is no reason to discuss them at this time.

The test described here is certainly not new (although I have not seen it in the literature) and is probably used by many of us. It is perhaps not the most accurate and certainly does not give all the information obtainable by some of the others. Its value lies in the ease of its performance, the little equipment used, the little time necessary in which to perform it, and, finally, the fact that it can be duplicated practically exactly each time that it is done.

Simply stated, the test consists of syringing ice water into the ear for five seconds. Water with ice cubes melting in it is always at the same constant temperature (36-37 F). No thermometer is needed; no extra time is consumed in producing a certain specific temperature.

A large metal ear syringe, one employed for washing out wax, is first cooled by pulling in and squirting out the ice water several times, and is then used for the ear syringing. The water is squirted in at a moderate flow (the exact rate does not matter unless it is so slow that the water is noticeably warmed as it runs in and out). This is continued for five seconds. A simpler way to determine seconds, as a photographer once told me, is to count at a normal rate, "one chimpanzee, two chimpanzees" etc., up to five. It is to be noted that the quantity of water is not mentioned, and does not matter. It is the time during which the water is in contact with the eardrum membrane that is important.

Nystagmus begins in 15 to 20 seconds and lasts 1 to 3 minutes in a normal person. Most patients have a slight to moderate shock reaction, not especially disagreeable. Extremes, of course, occur, from no reaction to nausea, vomiting, and severe vertigo. These severe reactions are uncommon. There is some discomfort because of the coldness of the water. However, this lasts but five seconds, and most patients are not unduly disturbed.

With an easy method such as this, one will find that one does far more caloric tests than if a more complex and time-consuming method were employed.

If pathologic results are found, then further information can be sought by other procedures.

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Submitted for publication April 11, 1957.

Presented at the Philadelphia Laryngological Society, March 2, 1957.

Society Transactions

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Malignancies of the Nose and Nasal Accessory Sinuses: Clinical Diagnostic Aspects. DR. ARTHUR LOEWY.

The term "malignancies" in relation to the nose and nasal accessory sinuses embraces many possibilities. Malignant tumors may arise from any of the diverse components of the area—from mucosa, bone, cartilage, blood vessels, lymphatic elements, neural tissues, pigment cells, from embryonal rests, and from other sources. However, a review of the published data shows that there is general agreement that, for practical purposes, malignancy in this area implies carcinoma, since 99% of the histologically malignant tumors are carcinoma and the great variety of other conditions accounts for 1% (Perzik, S. L.: Management of Cancer of Nasal Cavity and Paranasal Sinuses, *California Med.* 74:374 [May] 1951). As with medical statistics concerning similar diagnoses, the patient with the "1% tumor" is 100% involved by his infrequent tumor.

There are tumors of the nose and sinuses that are histologically benign, yet they exhibit clinical features generally ascribed to malignant tumors. Such a classification includes inverting papillomas, ossifying fibromas, chondromas, giant-cell tumors, and the salivary-gland type of tumors. While these tumors do not exhibit the pleomorphism, anaplasia, or mitosis associated with the microscopic diagnosis of malignant tumors, they do exhibit a marked tendency to recur when removal is incomplete. They erode and infiltrate adjacent tissue; they cause deformity and destruction, and they may prove fatal.

Early diagnosis of malignant disease is always an important feature in improvement of salvage rates by any modality of therapy. It is certainly important in malignant disease of the nose and sinuses in view of the proximity of vital areas to which the tumor may advance in its relatively early stages. Clinical diagnosis is the fundamental means of case finding, early or late, and depends upon evaluation of symptoms, examination by available means, and upon the histopathologic examination of properly selected biopsy tissue.

An evaluation of the symptoms most frequently reported as the presenting complaints indicates that they are neither unusual nor unique. Some are nasal symptoms; some are general head symptoms; others may be referred to the eye or to the mouth, but none heralds the dire consequences of an advancing, potentially fatal disease. It is significant that none of the symptoms can be considered as an early symptom, because each depends upon the erosion and invasion by, or enlargement of, the tumor. Furthermore, each is similar to the symptoms of a variety of benign nose, sinus, eye, or dental diseases. These are obstruction, discharge, bleeding, deformity, swelling, and pain.

Intranasal examination does have its limitations. In spite of mucosal shrinkage or anesthesia, there are "blind" areas to both anterior and posterior rhinoscopic view. The electric nasopharyngoscope may give a limited intranasal view behind septal obstructions, or in other areas difficult to expose; the smaller-caliber electric nasopharyngoscopes can also be introduced into the antrum by means of trocar puncture of the inferior meatus. Used in this manner, the instrument cannot obtain a biopsy specimen, but it may support indication for surgical exploration of the antrum by means of a sublabial antrotomy, in such conditions as intrasinus bleeding, bulging of the lateral nasal wall, or cheek swelling without break-through. Fundamentally, clinical diagnosis depends upon an awareness of the possibility of the presence of malignant disease and the biopsy of suitable tissue.

The gross appearance of this group of tumors is an unreliable diagnostic acid. Intranasal tumors may invoke a polypoid response in the adjacent normal tissue or may themselves have polypoid features. Erich has reported papilloma, fibroma, plasmacytoma, hemangioma, pyogenic granuloma, and carcinoma, all simulating polyps (Erich, J. B.: Symposium: Errors in Early Diagnosis and Treatment of Cancer in the Upper Respiratory Tract, *Tr. Am. Acad. Ophth.* 60:424, 1956). A. H. Miller

has related a series in which 3% of presumed benign polyps demonstrated malignant change not suspected (Ibid, in Discussion) clinically. This type of evidence should suggest histologic examination of all tissue removed.

Case presentations illustrate (*a*) the polypoid character of some tumors; (*b*) the symptoms referred to other organs or areas—ocular and dental; (*c*) the resemblance between tumor and acute sinus disease; (*d*) delayed diagnosis based on delay in obtaining suitable biopsy material.

Evaluation of delayed diagnosis demonstrates that the delay may be based on the sometimes misleading symptoms as illustrated: symptoms that direct attention to other organs, or symptoms that resemble benign, self-limited disease. It may also be based on misjudgment or artifact at the laboratory level, where areas of edema rather than true tumor are sectioned, or where judgment is passed on the basis of examination of relatively benign areas within the bulk of the tumor. Thus, where clinical diagnosis of malignancy is suspected, a negative histopathologic report should not be regarded as a final pronouncement; repeat biopsies may be in order.

In conclusion, the fundamental move of clinical diagnosis in malignant disease of the nose and sinuses rests upon obtaining a satisfactory biopsy specimen of representative tissue. This, in turn, depends upon an awareness of the possibility of malignant disease causing such common symptoms as obstruction, discharge, bleeding, deformity, swelling, and pain.

Roentgenological Diagnostic Aspects. Dr. John H. Gilmore.

The x-ray examination of the paranasal sinuses and nasal passages plays a very important part in the management of the patient with suspected neoplasm in these structures. From the x-ray findings one can often tell whether or not a tumor is present, whether it is benign or malignant, where it had its origin, and how far it extends.

Importance of tomographic study of the nasal passages was stressed with demonstration of a benign lesion, a rhinolith.

Numerous malignant neoplasms of the maxillary sinuses were demonstrated from very early to far-advanced findings. The technique of the x-ray examination was stressed. A balanced technique to show both soft tissue and bone detail is very important.

The appearance of abnormal density in the sinuses was shown. The density of a malignancy is greater than either polypoid degeneration of the mucous membrane, which has a ground-glass appearance, or the variable density of thickened membrane and exudate. The only abnormal density of the sinuses greater than that due to malignant neoplasm is the osteoma.

The value of tomography in determining the extent of involvement of a malignant neoplasm beyond the sinus of origin was shown, and how the point of "break-through" can be identified.

In differential diagnosis conditions included were mucocele of a frontal sinus, numerous osteomata of ethmoidal and frontal sinuses, and osteitis.

The demonstration was concluded by stressing the importance of examination of additional areas such as the chest which, at times, will give very important and definite information as to the existing situation in the sinuses.

Indications for Surgery. Dr. Irwin D. Horwitz.

While the theme of this discussion is the surgical approach to cancer of the nose and paranasal sinuses, a more appropriate title would be the best methods of treatment for the patient with cancer in this area.

This is not a forum for airing philosophical views, but the treatment of a patient should not be decided by the often antagonistic proponents of different modalities of therapy.

Surgery alone is not efficacious in the management of cancer in this area. This has been our experience, despite the excellent results reported by Ohgren (38%) and New (40%). Ohgren reported a series of 187 cases, 149 of which were treated electrosurgically. However, of the 20 patients with a five-year survival, only 15 had carcinomas, while 4 had sarcomas, and 1 a mixed tumor. This gives a cure rate of 10% for carcinomas. The objection to New's statistics, and not to the validity of his work, is that he selected his cases, rejecting almost half of the patients as unfit or unsuited for surgery. In the cases to be reported, all patients registered are considered, even those too ill to survive therapy.

Hendrick, in a recent article, states that neither surgery nor irradiation alone is satisfactory. He followed a method of therapy similar to ours but differing in that the irradiation was given before surgery. His series is too recent to include five-year salvage rates, but his three-year salvage rate is excellent—14 of 19 patients living.

The plan of treatment followed by us at the University of Illinois is adequate surgery followed by cancerocidal doses of irradiation. Any patient with a unilateral cancer that has not invaded the base of the skull and has not metastasized below the clavicles is considered operable. If there is any suspicion of orbital involvement, the contents of the orbit are exenterated and the infra-orbital plate removed. Half of the hard palate is always removed. The ethmoidal labyrinth is exenterated (and usually electrocoagulated), and the maxillary sinus walls are all removed, extending as far posteriorly into the pterygoid fossa as necessary. We have not appended any man's name to the

procedure (Hautant, Moure, Fergusson, etc.). Other surgery is considered inadequate and the Caldwell-Luc and Denker operations are mentioned only to be condemned as inadequate for tumor surgery.

Immediately postoperatively irradiation is begun, either intracavitary if the lesion seems limited, or external if the tumor seems widespread.

Since 1954, a total of 99 cases have been registered in the tumor clinic. Of these all but five have been carcinomas, and of the five none have survived. Two were lymphosarcomas, one a melanoma, one a salivary gland tumor, and the last a fibrosarcoma.

Of the cases, 57 were treated by surgery and irridiation, 41 by irradiation alone, and 1, far advanced and hopeless, by an experimental serum. There are to date 18 five-year survivals, sixteen have been treated by the combined method, two by irradiation alone. However, six cases have remained free of disease for a period of more than three years, but less than five; these have all been treated by the combined approach. This gives a five-year salvage rate of 18% and a projected five-year survival, counting patients who have been free of disease more than three years, of about 24%.

What does not show in the statistics, and what we consider vitally important, is that surgery gives immediate palliation from pain and fetor. The patients stand the surgery remarkably well, with little morbidity and no mortality. Age is the least barrier; of the 57 cases, 22 were older than 60 years. Rehabilitation in most cases is relatively simple, with a suitable prosthesis closing the palatal defect.

To summarize, patients with a malignancy of the paranasal sinuses have a better chance for a cure if treated by a combination of adequate surgery and cancerocidal doses of irradiation.

Indications for Surgery. DR. W. M. IRONSIDE (by invitation).

I thank you for the opportunity of taking part in the discussion of this rather difficult, but very interesting, subject. Following an able speaker such as Dr. Horwitz does not ease the problem before me. Bear with me if I repeat points already mentioned. It is as well to reaffirm the principle that all soft tissue be dealt with by electrosurgery, except when incising skin. Surgery in this field serves four purposes:

1. Diagnostic—to obtain a biopsy specimen and to estimate or confirm the extent of the lesion.

2. Drainage—to allow escape of pus and degenerate tumor following radiotherapy.

3. To provide an observation window in cases involving the sinuses.

4. To eradicate the malignant lesion—either alone or combined with radiotherapy.

Diagnostic.—Although cytological studies may be of help in the diagnosis of these lesions, most physicians agree that confirmation by biopsy is essential, and to obtain a good biopsy in suspected sinus lesions adequate exposure is necessary.

Drainage.—There is little question that some sort of drainage procedure is necessary before the start of a course of radiotherapy for a malignant lesion of the sinuses. Drainage allows the escape of purulent material so often associated with tumors in this site and degenerate tumor tissue following radiotherapy.

Concerning provision of an observation window, it is becoming more and more apparent that this is necessary in sinus lesions in order to provide an adequate follow-up after treatment. To await discovery of recurrence within a sinus at an antrostomy, or as an extension into the cheek or eye, is not acceptable today. The two sites usually used for these openings are the sublabial region and palate. The site chosen depends on the original site of the lesion and the treatment given. If the lesion has been largely palatal and surgery has been employed, a palatal window is the choice. If, however, the sublabial approach has been used, this is the obvious site for the window. These windows should be made at three to four weeks after the completion of a course of radiotherapy. It is possible at this time to check the result of the radiotherapy and deal with remaining malignant tissue.

The fourth point in which surgery is used to eradicate the lesion suggests a more complex problem.

In the brief time allotted it would be convenient to tabulate indications for curative surgery, but with malignancies of the nose and sinuses it is impossible and would be misleading. All that can be hoped for is a few guiding principles.

In malignancies of, for instance, the larynx which, fortuitously, is also to be discussed, the problem is not so great. In this site the type of lesion is nearly always the same histologically, the site of the lesion is nearly always readily and early visible, and the lymph drainage field is accessible surgically. Bearing these points in mind, and having considered one's own experience and the results obtained by various methods at other centers, it is possible to be more definite about indications for curative surgery.

Considering the points just mentioned as applied to the nose and sinuses:

A. *Type of Growth*.—More than two-thirds of the malignant growths in the nose and sinuses are carcinomatous. The majority of the remainder are sarcomatous. Some of these sarcomata are very radiosensitive, and a five-year cure rate of 50% has been claimed in a small series with radiotherapy alone. Certainly surgery can offer no better results, and it has been suggested that it may even be

dangerous. So, in these cases, surgery is of benefit only in order to obtain a biopsy specimen and provide drainage and an observation window. With carcinomata and the more radioresistant tumors, most authorities agree that the best results are obtained with a combination of surgery and radiotherapy. The results which can be obtained by combined treatment show about 30% to 35% five-year cure (Wilson and Windeyer and Capps). This is an improvement on either surgery or radiotherapy alone. As an example of the results obtainable by radiotherapy alone, let me present a short series of patients treated in Edinburgh.

They received one of three forms of treatment: (1) intracavitary radium; (2) deep x-ray, and (3) a combination of 1 and 2. Of the 35 patients in this series, eight, or 23%, were alive after five years. It may be of interest to the therapists present to know that the only case treated through wedge filters obtained a five-year cure. The problem, however, is to decide which form of treatment should be offered first.

On reviewing the literature, there appears to be little difference which treatment is given first, the results obtained being the same. As a result of the extensive necrosis and delayed or incomplete healing which occurs following radiotherapy of lesions which have involved the skin, in these cases it is probably a sound practice to operate first and follow up with radiotherapy. As a result of brief experience of a very limited series treated with a 4 mv. accelerator, it is felt that more cases should have this form of therapy primarily. With these machines the surface dose is low and so the problem of skin necrosis does not present so frequently. Again, as a result of low surface dose, it is possible to irradiate through the open eye without inducing eye complications seen in the past with older methods. Furthermore, the beam is more deeply penetrating, and so the tumor area can be more accurately irradiated. As already mentioned, this is a very short series and it is far too early to give any definite figures, but early results are promising.

It might be convenient at this stage to consider the advisability of excision of the maxilla as a planned procedure. So often it is unnecessarily radical and frequently not radical enough. It is felt that when one is embarking on surgery to eradicate the disease, there should be no set procedure in mind. Once the route has been decided, depending on the site and extent of the lesion, one should aim at removing the tumor with a margin of healthy tissue as far as possible. While excision of the maxilla may occur while doing this, it is considered a mistake to start off with this in mind.

B. *The Site.*—The site of the growth also influences the decision as to the treatment. In localized lesions of the septum it is probably wise to offer surgery, as there is a fair danger of cartilage necrosis with radiotherapy.

C. *Lymph Drainage Area and Its Accessibility.* Unfortunately, most of these tumors tend to drain into the retropharyngeal lymph nodes. As a result, it is exceedingly difficult, if not impossible, to remove these involved nodes by surgery, and radical neck dissection is not likely to meet with much success.

On the other hand, it is as well to remember that the results obtained by radiotherapy in dealing with cervical metastasis are not very cheering.

Surgery, of course, plays a large part in the treatment of recurrences at the primary site, as a second course of radiotherapy is generally impossible if the first course has been adequate, and local radium has only a limited use in these cases.

In conclusion, in all cases surgery is necessary for obtaining a biopsy specimen, in all sinus lesions for providing drainage, and in preparing an observation window. When to eradicate the lesion by surgery is a more complex matter, and it can be appreciated that the decision can be made only by a closely cooperating team consisting of at least the surgeon, the radiotherapist, and a specialist in prosthetic work.

Indications for Irradiation. DR. MARION F. MAGALOTTI.

The treatment of cancer is difficult anywhere in the body and fails too often, even with the most skilled surgery or radiation therapy. Cancer of the paranasal sinuses is especially difficult because of their anatomy, that is, the predominance of bone and the scarcity of soft tissue, the latter being chiefly a thin lining of mucous membrane from which most of these cancers arise. The bone acts as a barrier to the extension of the cancer but does become infiltrated with tumor long before it is demonstrable on an x-ray film. Primary carcinoma of the frontal and sphenoid sinuses is uncommon; the antrum is most commonly involved and the ethmoids second.

The occasional adenocarcinoma and primary bone tumors are best managed by surgery. Lymphosarcoma and lymphoepithelioma are very radiosensitive and best handled by radiotherapy. The overwhelming number of malignant lesions in this region are squamous-cell carcinoma. The management of these cases should be decided with the mutual cooperation of the otolaryngologist and radiotherapist. Under no circumstances should radiation therapy alone be chosen with the idea that it is easier for the patient. That is incorrect. There is a definite morbidity associated with adequate therapy in this region aimed at a cure. The discomfort of radiation reaction, tumor and bone slough, secondary infection, and finally sequestration cannot be denied. Of course, the surgeon has his problems, too.

Larsson and Martensson consider the following to contraindicate surgery: (1) advanced age; (2) poor general condition, or complicating diseases having a doubtful prognosis; (3) roentgenologically demonstrable destruction of the base of the skull or of the pterygoid process; (4) very extensive bone destruction or considerable bilateral spread; (5) extensive involvement of the soft tissues of the cheek or the external nose, where radical operation would entail large and disfiguring defects; (6) tumorous infiltration of the mucous membrane in the nasopharynx; (7) inoperable lymph node metastasis; (8) generalized metastasis, and (9) refusal by the patient and in severe mental disturbances that would make a defective condition difficult to overcome.

In our department, the management of a case is decided in cooperation with the attending otolaryngologist. The decision may be surgery, external radiation or intracavitary therapy, or a combination of these. Patients with cancer may be in a serious state of malnutrition, with secondary infection and anemia. Efforts should be made to improve or correct these deficiencies before beginning specific therapy, whether it be radiation or surgery. The administration of antibiotics, parenteral and tube feeding, and blood transfusions are of vast importance in preparation for surgery, but how often it is forgotten in the preparation for radiotherapy!

A few cases will be briefly reviewed to illustrate the various methods of irradiation which we use:

A 21-year-old Negro woman was seen in November, 1954, with the history of progressive swelling of the left cheek, periodic nose bleeding, and difficulty in breathing. The clinical examination revealed a mass within the left nasal fossa arising from the lateral wall. [Slide] The x-ray film showed cloudiness of the left antrum with osseous changes of the medial wall. The biopsy report was squamous-cell carcinoma. [Slide] A plaster cast is seen of the patient's face which was used to prepare the lead mask. Also seen is the lead mask which was swaged from a 2 mm. sheet of lead. The two 5 cm. in diameter anterior openings and one 7×7 cm. lateral opening can be seen in the mask which served as ports of therapy. The appropriate angles were determined to direct the beam from each port. A tumor dose of 5000 r was delivered in six weeks to a volume of tissue which encompassed the tumor, with 200 kv. H. V. L. of 2 mm. Cu and 50 cm. distance. There was a gradual slough of the left inferior turbinate and a portion of the medial wall of the left antrum. The patient did well clinically and was instructed in the daily cleansing of the left nasal fossa. In March, 1956, a sequestrum was removed under general anesthesia from the left nasal fossa.

This attractive young girl left Chicago before I could get a photograph for this meeting. She joined her husband who is in the service in Japan. She has been in good health with no prosthesis, and no evidence of disease approximately two years after external therapy.

The second case is a 19-year-old Negro woman who was first seen in the ENT clinic in October, 1950, complaining of bleeding from the right nostril. A large polyp was found arising from the floor of the right nasal fossa. This was excised and the pathological report was basal-cell carcinoma. The patient did not return for 10 months. At this time, the entire right nasal fossa was filled with tumor. [Slide] As shown, x-ray therapy was given through two anterior ports delivering 3600 r at a depth of 4 cm. Following x-ray therapy, the right nasal fossa was emptied surgically. Residual disease was found on the floor of the nasal fossa extending up to the lateral and medial wall. The second biopsy now showed squamous-cell carcinoma. As shown on the slide, radium therapy was given with a single tandem, at two sittings, delivering each time 2500 gamma at the periphery of a cylinder, 2 cm. in diameter, within one week's time.

A gradual slough of the floor of the nasal fossa with the nasal septum and lateral wall followed, necessitating a prosthesis for the hard palate. The patient left the city and was seen again two and one-half years later. In August, 1955, a large sequestrum was removed under general anesthesia; it involved the central portion of the maxilla, the floor of the nasal fossa, and portion of the nasal septum. No tumor was found. [Slide] This photograph taken recently shows the patient, now aged 24, five years after combined x-ray and radium therapy, with no evidence of tumor. She wears a prosthesis.

The third case will be briefly reviewed and shows a combined management of surgery, x-ray, and radium, in that order. A 52-year-old white man was seen in June, 1955, with a history of surgical exploration and partial antrectomy two months previously. Tumor was obvious on the walls of the amphitheater and the pathological report was anaplastic squamous-cell carcinoma. X-ray therapy was started and 2100 r (air) was given through a 7×7cm. anterior port, and the same amount through a similar lateral port in three weeks with 200 kv, H. V. L. 2 mm. Cu and 50 cm. distance. This was followed immediately with intracavitary radiation.

[Slide] Several types of intracavitary sources are shown for the nasal fossa, antrum, and surgical amphitheater. The smallest source is used for the antrum, being inserted directly into the antrum through a small opening in the supracanine fossa, as advised by Dr. Paterson of England. The source

on the right was used in the nasal fossa of the second case we discussed. The two plastic-covered sources are used for intracavitary therapy within the surgical amphitheater, the size used depending upon the volume to be treated. The smaller plastic-covered source was used in this third case. It was introduced with no anesthesia, being held in place with a sponge.

[Slide] The film shows the plastic-covered source in the surgical amphitheater, the visible portion being the brass tube holding the cobalt sources. This source was left in place for six days, delivering 6000 gamma r to the periphery of a 5 cm. diameter sphere.

[Slide] This patient recently returned after a six months' absence. The skin has retracted and exposed a portion of the maxilla. Surgical resection is being planned. The surgical amphitheater is clean, with no evidence of tumor, 18 months after radiotherapy. None of these cases developed cervical metastasis.

In conclusion, we know there is much to learn about the management of cancer. The ideal treatment will be found someday in the future to replace our rather primitive methods, but, until that day arrives, let us approach these unfortunate patients as a team, with prejudice in only one direction—against cancer!

Summary: Dr. Samuel J. Pearlman: From the presentations you have had, it is fair to say that the criteria for the treatment of malignancies of the nasal cavities and their accessory sinuses are not rigid. Treatment may be limited to surgery alone, to radiation therapy before and after surgery, and to radiation therapy alone.

The latter may be in the form of x-rays, or radium at a distance in the form of the bomb, or radium locally.

Schuknecht says some neoplasms in this area are so radiosensitive that they may be treated by radiation therapy alone. He says that surgical resection should not be attempted when there is no reasonable chance for complete removal of the neoplasm. "The criteria for operability are determined to some extent by the surgeon's skill and courage" (Schukneck, H. F.: The Surgical Management of Carcinoma of the Paranasal Sinuses, *Laryngoscope* 61:874 [Sept.] 1951).

He indicates the contraindications to complete surgical removal and named among them invasion of the skull, nasopharynx bilateral involvement, and distant metastasis. He thinks that 30% of all patients with carcinoma of the accessory sinuses are inoperable and should receive palliative radiation therapy.

Lymphatic involvement offers some food for thought. It is apt to be late; resection of the nodes when involved must of necessity be discontinuous, thus violating the principle of removing the tumor and its lymphatic supply en masse.

In this connection, it is of interest to know that Lyall considers the neck one of the few areas in the body where efficient node dissection can be carried out (Lyall, D.: Treatment of Operable Cancer of the Breast, *Surg. Gynec. & Obst.* 103: 318 [Sept.] 1956).

The commonest early symptoms of benign and malignant growths in the area under discussion, you have been told, are obstruction to breathing, nasal discharge, and nosebleed. These symptoms occur in other diseases too. Other diseases are many, and carcinomata are relatively few; still these obscure symptoms in persons usually past 50 call for careful scrutiny until they have been clarified.

In line with this thought, it has long been known that cancers differ markedly from one another, as evidenced by the variety encountered in the series of 72 cancers of the nasal fossae and paranasal sinuses reported recently by Hendrick; he names squamous-cell carcinoma, adenocarcinoma, malignant melanoma, lymphosarcoma, lymphoepithelioma, myxosarcoma and cylindroma (Hendrick, J. W.: Treatment of Cancer of the Nasal Cavity and Paranasal Sinuses, *Surg. Gynec. & Obst.* 102:322 [March] 1956). The manner in which these various types develop, their rate of growth, their invasiveness, and the way in which they spread to lymphatics and to distant parts of the body must, and does, vary greatly.

Even the concept of what is early and what is late is hard to define. Certainly there are patients who delay their coming; there are physicians who delay their diagnosis, and there are a large number where diagnosis simply cannot be made "early" in any sense of the word.

Lastly, in carcinoma of the maxillary sinuses the site of origin within the confines of the cavity determines the patient's fate; in one area where the orbit or the skull are invaded early, the prognosis is worsened; in another, the site remains more confined and yields more easily to treatment.

The tendency to increase the scope of operation for carcinoma is not limited to this area, it applies here as it does in other areas of the body and in recent times has been evaluated critically. It is fair to point out that the tendency toward radicality is not due altogether to an increase in surgical skill, but rests in large part on all those factors which have made all surgery more successful in recent years. These factors are, as you all know, dependent upon better anesthesia, blood loss replacement, control of infection by antibiotics, restoration of body fluid loss, and electrolyte balance as well as improved building up of the patient's body by proper diet, vitamins, etc.

These surgical procedures cannot be done by the larger number of laryngologists, well trained though many of them are nowadays. The treatment for these conditions must, in large part, remain in the hands of the few who have the opportunity to become most expert and whose duty it is as teachers to bring the rest of the profession up to date over the necessary period of time.

Here I quote Zinninger: "Regarding the question of morbidity, deformity, or disability of the patient following supraradical operations, there is considerable difference of opinion among both surgeons and patients. Most of them would like to eat their cake and have it too. The patient, particularly, does not want a disability or deformity but he does wish to be cured. The surgeon here needs to take the initiative. The patient is a layman who will in all probability be guided by the surgeon's advice, and the latter can 'sell him' or discourage him from a given course. The surgeon should not take advantage of his knowledge to convince the patient that a big operation is better for him than a less extensive one unless there is clear-cut evidence of the superiority of one operation over another. Patients who become partial outcasts because of disfigurement, invalids because of inability to eat or properly digest food, or who suffer long periods of disability before they finally can resume more or less normal activities, may ultimately feel that they have paid a high price for the privilege of living unhappily" (Zinninger, M. M.: Supraradical Operations for Cancer, *Surg. Gynec. & Obst.* 102:492 [April] 1956).

To the above may be added the odor of bone injured by radiation therapy or electrosurgery, which may not disappear for considerable time, and only after complete sequestration has taken place.

"Different procedures each present different hazards and challenges. Not infrequently, of course, the operation may change an apparently hopeless cripple into a self-respecting and useful member of society, but surgeons must remember that the opposite effect may also occur, and must, therefore, exercise their most mature and careful judgment based on well-documented evidence. On the whole, while it is recognized that morbidity and crippling of one sort or another may follow these extensive operations, in many instances it is not too serious a problem."

In concluding, it must be emphasized again that there is no sole and proper treatment, as each case must be individualized; where possible, a cure by less rigorous means is preferable, and the physician must maintain a constant conscientious revision of method.

There is certainly no intent on my part to preach a form of therapeutic nihilism, nor do I mean to decry the increasing scope of the modern approach. In this connection we must agree with Lyall, who says, "An attempt to improve a procedure is not an admission of failure, but rather it is the duty of all physicians."

The Possibilities of Betatron Treatment in Carcinoma of the Paranasal Sinuses and of the Larynx. DR. LEWIS L. HAAS.

This paper was published in full in the August, 1957, issue of the ARCHIVES, pp. 165.

Betatron Therapy of Laryngeal Carcinoma. DR. ARTHUR L. RATKO.

Since Dr. Haas has discussed the physical and radiotherapeutic aspects of this subject, my remarks will be concerned with clinical impressions obtained from observations of nine patients, so treated.

It would be pertinent at this time to briefly describe the classification we have used, namely, the Swedish classification.

I. Anterior two-thirds of one true cord.

II. Either bilateral cordal involvement or extension across the anterior commissure.

III. Extension beyond the true cords, fixation of a cord, no adenopathy.

IV. All other lesions.

Of the nine cases, the distribution is as follows: Class I, none; Class II, two; Class III, six, and Class IV, one.

Without going into the frequently debatable argument of radiotherapy *vs.* surgery, I might say that evaluation of all cases, either by the attending physician or the tumor board, resulted in a recommendation of total laryngectomy in every case with one exception, which I will discuss later. In other words, it was felt that the anticipated cure rate in these cases would be higher if total laryngectomy was done despite any question of function, preexisting disease, etc. Certainly, one could not anticipate an 80% to 95% cure rate which could be obtained with either modality of therapy in an early lesion as seen in Class I.

Our particular interest in these cases was centered in evaluation of three factors: *A*, course of the patient and evaluation of the tumor during therapy; *B*, post-treatment sequelae, and *C*, end-result.

A. In the past, using conventional 200 kv therapy, the physical well-being of the patient has been compromised by several deleterious effects of radiotherapy.

1. Edema of both airway and hypopharynx not infrequently precluded adequate respiratory exchange and/or nutrition. While tracheotomy, tube feeding or gastrostomy was not usually necessary, using conventional therapy, their occasional necessity increased the morbidity and discomfort of the patient. Then, too, there was the occasional patient who required a permanent tracheotomy because of edema of the glottis which never subsided.

2. The hyperemia and edema seen during conventional therapy all too often made it extremely difficult, if not impossible, to adequately follow the lesion carefully, either during or after treatment. It is from these cases, I believe, that the highest incidence of failure of radiotherapy comes, since we cannot see that the lesion is not responding adequately.

B. With modern techniques of fractionation, multiple ports, and adequate filtering, radionecrosis of the larynx, or for that matter the overlying skin, has become rare. This, indeed, is fortunate, since I know of no more distressing situation than to obtain a good therapeutic result, sparing the larynx, only to have to resect it later because of the severe pain and debilitation which results with subsequent radionecrosis. One other sequela, which we have not been able to eliminate, is the endarteritis following therapy which increases the hazard of surgery considerably, despite opinion to the contrary.

C. While the lesions in the cases under discussion were largely of the superficial variety, their location, particularly posterior extent, would yield a five-year cure rate of roughly 50% to 60% if total laryngectomy were done. With radiotherapy we would anticipate a lower cure rate, particularly the case with adenopathy which we feel only rarely can be sterilized with radiotherapy.

Rather than give charts and statistics, which all too often are misleading, I should like to discuss these cases under the three headings above.

A. (1) In contrast to the hyperemia and edema seen within the first 7 to 10 days with conventional treatment, they appeared generally between the second and third week with betatron therapy. We chose to grade the reaction as slight, moderate, or severe. In seven cases the edema was only slight, moderate, or severe. In seven cases the edema was only slight, in one case moderate, and in one severe. In all cases but one, the edema subsided almost entirely within two to four weeks after therapy. Hyperemia, however, ranged from moderate to intense in all cases, particularly the hyperemia of the lesion itself—so much so that the lesion usually stood out quite clearly from the adjacent mucosa. In all but two cases the hyperemia subsided, leaving only minimal telangiectasia.

(2) As previously stated, the intense hyperemia seen in most of the lesions made it simple to follow the course of the lesion. Because of the very limited edema, visualization of the lesion was excellent. It should thus be possible to predict, with reasonable accuracy, which lesions are responding favorably to therapy justifying its completion, or those in which radiotherapy should be discontinued and surgery carried out. In one of these cases the cord was entirely smooth approximately four weeks after therapy was begun.

No case required tracheotomy or supplementary feeding measures during therapy.

B. Since the skin received the smallest dose in betatron therapy, there were no cases with significant skin damage either during or after therapy. In only one case did we feel that radionecrosis had been produced. This was one of our earlier cases who received 10,000 R. T. D. in only 40 days; he died of a combination of radionecrosis plus persistent tumor three years and five months after therapy. One patient required tracheotomy four months after completion of therapy and died one month later with no information being obtainable with regard to either persistence or radionecrosis.

C. These cases treated ranged in age from 32 to 81 with the majority being in the fifth and sixth decades. There was one woman and eight men. Three patients have died—one with known radionecrosis and persistent tumor, one of carcinoma of the lung. The third cause of death is unknown. Five patients are alive and free from disease from 13 months to six years with betatron therapy only. The sixth case, of considerable interest, I would like to discuss briefly.

The patient, aged 75, complained of hoarseness and dysphagia for one month. Mirror laryngoscopy revealed an ulcerative lesion, posterior one-third, at cord with extension to the arytenoid and partial joint fixation; he had a firm, movable node in the left side of the neck. Diagnosis: epidermoid carcinoma. Treatment: 1. Surgery was contraindicated because of an I. V. heart block and the patient was an extremely poor risk for monobloc resection of neck and larynx. 2. 8600 R. T. D. was given to larynx and neck node separately April 7, 1954, and May 27, 1954.

Course: The laryngeal lesion disappeared entirely as did the node. On October 4, wedge biopsy and radon seeding implantation were prescribed for recurrent nodule at neck, as well as for recurrent carcinoma. Left side of neck was dissected on November 16, 1954; two tumor nodules showed central necrosis but persistent peripheral islands of tumor. The patient experienced a breakdown with partial slough of upper skin flap which healed within three months. The patient was free of disease and last seen on Sept. 5, 1956.

Here it was possible to eradicate a lesion by a combination of therapy with an apparently excellent result. It might also be said that the motility of the arytenoid is now normal.

Summary

While the small number of cases presented should not lead to generalizations, certain facts are readily apparent.

1. There is a marked reduction in the undesirable aspects of radiotherapy both during and after therapy.

2. There is a significant reduction in post-treatment sequelae.

3. The over-all results compare favorably with results of either surgery or conventional radiotherapy; perhaps they are even better.

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

Raymond W. Kerwin, M.D., President
Stanton A. Friedberg, M.D., Secretary
Monthly Meeting, Dec. 3, 1956

Possible Value of Nontoxic Concentrations of Fluorine in the Prevention of Deafness from Otosclerosis and Fibrosis: Its Possible Value in the Prevention of Other Diseases. DR. ALFRED LEWY.

The addition of fluorine to the drinking water of Chicago south of 39th Street for the purpose of preventing tooth decay, brings to the fore again the question of other therapeutic possibilities. This experiment in public health follows many years of investigation by the dental profession, but there is also considerable literature on the pathological effect of fluorine. It is my purpose tonight to repeat a paper published by me (*Arch. Otolaryng.* 39:152 [Feb.] 1944), in which I refer also to two other previous publications on this subject as it related to otology and perhaps to other disorders affecting the bone. These were read before the American Laryngological, Rhinological and Otological, and the American Otological Societies, respectively. The present contribution has not been read before any other society.

The purpose of this paper is to present to members of the medical profession what I believe to be a promising and justifiable long-range experiment in the use of fluorine for the prevention of some forms of deafness, and to suggest investigations which may lead to its trial in other fields of medicine.

The influence of fluorine in living bone and fibrous tissue, especially ligaments, has been the subject of considerable investigation for many years. The literature on this subject was summed up (Roholm, H.: Fluorine Intoxication: Clinical Study with Review of the Literature and Some Experimental Investigations, English translation, London, H. K. Lewis & Co., Ltd., 1937.) in a monograph based on a study of cryolite workers and miners in Iceland. Roholm has 893 bibliographic references. The dental literature is also much concerned with dental fluorosis resulting from the drinking of water containing fluorine, and many investigations have been reported from various parts of the world.

(Black, G. V., and McKay, F. S.: Mottled Teeth: An Endemic Developmental Imperfection of the Enamel of the Teeth, Heretofore Unknown in the Literature of Dentistry, *Dent. Cosmos* 58: 129, 1916.

Dean, H. T., and others: Domestic Water and Dental Caries; Additional Studies, *Pub. Health Rep.* 57:1155, 1942.

Schour, I., and Smith, M. C.: Injections of Sodium Fluoride on Enamel and Dentin of Incisor of Rat, *Proc. Soc. Exper. Biol. & Med.* 32:1, 1934.)

The effect extends to the dentin as well as to the enamel, hence the use of the term "dental fluorosis" instead of "mottled enamel," the term relating to the external visible sign (Schour, I., and Smith, M. C.: Experimental Dental Fluorosis, in Fluorine and Dental Health, Publication 19, American Association for the Advancement of Science, 1942). It appears further, that while toxic quantities of fluorine, variously estimated but approximating 2 ppm or more in the drinking water, will produce dental fluorosis in children, there is a great lessening of dental caries in such communities as have fluorine in their drinking water in less than toxic concentrations, say about 1 ppm, as compared with communities which have no fluorine at all in the water supply. The whole subject of the effect of fluorine on dental caries is summarized in a report of the Council on Dental Therapeutics by Harold C. Hodge, Ph.D., of the Department of Biochemistry and Pharmacy of the University of Rochester School of Medicine and Dentistry (Hodge, H. C.: Is Fluorine a Therapeutic Agent for Dental Caries? *J. Am. Dent. A.* 29:2063, 1942), who claimed the reduction by one-half of the incidence of new caries in children by the use of water containing 1 ppm of fluorine, in which con-

centration it is not toxic. The subject has been considered more recently. (Ast, D. B.: The Caries-Fluorine Hypothesis and a Suggested Study to Test Its Application, *Pub. Health Rep.* 58:857, 1943.)

Investigations of the direct effect of fluorine on bacteria in the mouth (Bibby, B. G., and Van Kesteren, M.: Effect of Fluorine on Mouth Bacteria, *Dent. Res.* 19:391, 1940) indicate that a high and toxic concentration is necessary for direct bacteriostatic action. It is evident that a pre-existing change in the metabolism of the dental tissues is essential for the advent of caries, which is a bacterial process only in its terminal manifestations.

In 1928 I read a paper (Lewy, A.: Influence of Fluorine on the Bony Labyrinth of the White Mouse: Preliminary Report, *Arch. Otolaryng.* 8:315, 1928) before the American Rhinological, Laryngological and Otological Society, in which I attempted to show by feeding experiments that fluorine had an effect on the bony labyrinth, and in 1934 I reported to the American Otological Society further observations (Lewy, A.: Influence of Fluorine on the Bony Labyrinth of the White Mouse: Further Observations, *Arch. Otolaryng.* 20:693, 1934) in which I demonstrated a deposit of osteoid tissue on the wall of the labyrinth near the oval window. In the first-mentioned paper I made the suggestion that fluorine may have a therapeutic effect in otosclerosis and quoted Escat (Escat, E.: Monographie, Otolaryng. Internat. 7:653, 1922.), Schulz (Schulz, H. P.: Vorlesungen uber Wirkung und Anwendung der unorganischen Arzneistoffe, Leipzig, Georg Thieme, 1920.), and Schüssler (Schüssler, W. H.: Manual for the Biochemical Treatment of Disease, translated by L. F. Tafel, ed. 25, Philadelphia, Boericke & Tafel, 1898). In this disease, which is subject to spontaneous fluctuations and even arrest, the normal course of which extends over so long a span of years, the experience of no one man is sufficient to enable him to arrive at conclusions.

The demonstration that fluorine is preventive of dental caries and that this prevention is exercised by an effect on the metabolism of bone rather than by local bacteriostasis has awakened inquiry as to the possible value of fluorine in the prevention of deafness. I had promised Dr. Ernest M. Sydell during his presidency of the American Otological Society (1942) to present a paper comparing the incidence of deafness in communities having fluorine-containing drinking water with the average for other communities. This has not been practicable until now, when a survey of deafness in the school children of 68 of Illinois' 102 counties, under the supervision of Dr. Walter Theobald, is available. These tests were made with the group audiometer for screening out children with defective hearing. The children so discovered were then tested individually with the audiometer. This investigation has been considered in connection with a report of Dr. Charles F. Deatherage, head of the Division of Dental Health Education of the Illinois State Department of Health, covering 78 localities in 32 counties in the State (Detheridge, C. F.: Mottled Enamel from the Standpoint of the Public Health Dentist, in Fluorine and Dental Health, Publication 19, American Association for the Advancement of Science, 1942).

A total of 132,572 children were examined. Those with defective hearing numbered 6,328, an average for the State of 4.7%.

In the counties whose water does not contain fluorine the total number of children examined was 109,869; the number with defective hearing was 5,406; the percentage defective was 4.9.

In four counties near Chicago whose drinking water contains fluorine not to exceed 1.4 ppm, from which statistics were available, 20,488 children were examined, the number with defective hearing was 574; the percentage defective, 2.8. In Chicago alone 21,200 children were examined, 922 of whom were found defective, a percentage of 4.3. Chicago drinking water comes from Lake Michigan and is fluorine-free.

These numbers are sufficient to overcome to a large extent the elements of coincidence and of statistical error. The population of the four counties having fluorine in the drinking water from which statistics were available is varied. DuPage is largely a medium- to high-grade suburban residential district plus some farming districts; Will County is largely an industrial and mining district and contains the city of Joliet, with over 42,000 inhabitants; Kankakee is an industrial and farming community; Kendall County contains no large cities and is largely a farming district.

Much remains to be done with this idea. Wider investigation may upset it. A more detailed correlation of the defective persons as to family history and exact diagnosis is necessary. One cannot know how many potential otosclerotic or fibrotic ears are in the group. The few pairs of identical twins with a deafness heritage now being studied by Fowler (Fowler, E. P.: Otosclerosis in Identical Twins, *Tr. Am. Otol. Soc.* 32:166, 1942); may offer an occasional opportunity for controls, study of blood serum calcium and phosphorus and the effect of the serum of otosclerotic patients on labyrinthine bone (Grahe, K., and Griebel C.: Die Bedeutung der allgemeinen Stoffwechselstorung bei der Otosklerose, *Ztschr. Laryng. Rhin. Otol.* 22:162, 1932. Weitere abbaustudien bei Otosklerose, ibid 24:149, 1933) might be extended to include the effect of fluorine on such bone as well as its

effect on the endocrine system, especially the parathyroid glands.

Ast proposed testing the accuracy of the fluorine-caries hypothesis by placing nontoxic doses of sodium fluoride (to equal 0.8 ppm of fluorine) in the public drinking water of one community. The plan is to be studied 10 or 12 years. Localities are to be selected as to exclude variables as far as possible. The chemical composition of the water, past and present, the composition of the population as to size, color, nativity, age, sex, and economic status, the geographic and climatic conditions, diet, and other conditions must be considered, and the same person or persons should conduct the investigation. In the same community the investigation could be extended to the question of deafness, and it could be appropriately done by the United States Public Health Service, an otosclerosis committee of the American Otological Society, or any other authoritative body with proper facilities. (Spira, L.: Aetiology of Otosclerosis, *J. Laryng. & Otol.* 58:151, 1943.)

It is further suggested that internists and orthopedic surgeons may find here a fertile field for investigation of osteoarthritis and other diseases of the bone, beginning with a survey of the incidence of these diseases in localities which have fluorine in their drinking water in not too high concentration.

Dr. Spira in a later contribution in *Experimental Medicine and Surgery*, states his belief that fluorine exerts its influence through the innervation of the parathyroid glands, and in another article reports feeding experiments on mice producing bone changes.

My justification in presenting to you this rather old study is that it will probably take more than one lifetime. Efforts to get cooperation from various health departments have not succeeded. Even our neighbor, Evanston, whose health commissioner instituted organized hearing tests, had the bad luck of having the records lost by the school nurse in charge.

I am offering this as a suggestion to the next generation of otologists and perhaps to their successors. It may prove interesting to practitioners of other branches of medicine. Deleterious effects must also be guarded against.

Discussion

DR. WALTER H. THEOBALD: It is indeed stimulating to listen to a youthful man of more than four score years who has the same interest in otology which he has had during the many years I have known him (and that goes back quite a time), the same enthusiasm, and the same provocative mind, whether the interest be hypothetical or real. Tonight he is again bringing to our attention a subject which has caused more controversy, and even political feuds throughout the nation, than any other public welfare question. I refer, of course, to fluoridation of drinking water. Fluoridation is prevention, not mass medication.

However, Dr. Lewy's paper is not directed so much to the effect of fluorides on teeth as it is to their possible effect in producing changes in the bone. It has been pointed out that both osteomalacia and hyperostosis were observed when experimental animals were fed fluorides at relatively high levels of intake, but that at lower levels osteosclerosis was observed. However, these findings have not been helpful in understanding the nature of fluoride deposition in man.

The fluoride states are Illinois, Oklahoma, and Texas, and the low fluoride states, Indiana, New Hampshire and Washington, D. C. In the town of Kempton, Ill., where the fluoride content of the water was from 1.2 to 3.0 ppm, no evidence of bony injury was found by radiologic examination in 86 persons ranging in age from 7½ years to 71 years. Nor was there any evidence of damage found in 31 subjects, age range from 18 to 78 years from Bureau, Illinois, with 2.5 ppm fluorine in the water.

The reference Dr. Lewy has made to our survey of deafness in school children is impressive but not convincing—4.7% defective hearing in fluorine-free water localities compared to 2.8% in four counties with 1.4 ppm fluorine drinking water. Whether or not some of these children were potential otosclerotics, we do not know. It might be revealing if this same group of persons with defective hearing who have now perhaps reached the age of 40 could be reexamined otologically. It could very well throw some light on the subject of nontoxic concentrations of fluorine in the prevention of otosclerosis.

This is the kind of study which requires a generation or more to evaluate fluorine as a therapeutic agent. Perhaps some of our younger men might carry on from here with the ground work provided by Dr. Lewy.

DR. SHERMAN L. SHAPIRO: I would like to ask Dr. Theobald a question. How long had those people been exposed to fluorine, that is, the ones who had otological changes?

DR. THEOBALD: These children all were in the school years, up to the seventh grade.

DR. SHAPIRO: How much fluorine had they been taking?

DR. THEOBALD: They were in the areas where the water was fluorinated naturally.

Laryngologists' Aid in Mass Disaster: DR. T. C. GALLOWAY.

The importance of an open airway in acute suffocative attacks, especially those associated with infections, has been recognized since Galen. More

recently it has been realized that tracheotomy may be lifesaving in many other conditions, especially traumatic injuries of the larynx, chest, mouth, and jaws; craniocerebral injury and cerebral depression; shock, and flame and thermal chemical injury of the respiratory tract.

Anyone who believes the question of mass disaster is only an academic one should read, with a mind conditioned by the picture of ruthlessness in Hungary, of the devastation in Hiroshima by atomic bombs (Oughterseon, A. W., and Warren, S.: Medical Effects of the Atomic Bomb in Japan, New York, McGraw-Hill Book Company, Inc., 1956). Yet, that bomb was only a toy compared to the thermonuclear weapons now available.

In Hiroshima 25% of the 225,000 inhabitants died in four months; 33% of those dying did so the first day. Only 60 of 300 physicians could work, some with injuries. Only 3 of 45 hospitals were left usable.

The need for laryngological care of vast numbers of the few surviving doctors under chaotic conditions led us to devise a simple method to quickly open the airway. Such a tracheostome should be simple, relatively safe, usable by relatively untrained personnel, and easily mass-produced from standard equipment. We are certain the instrument may be much improved. We hope it might be of use in civilian disaster or even in isolated acute respiratory emergencies.

Older trocar-type tracheostomes usually designed to be inserted through the cricothyroid could be of only temporary use, and in my experience were not of much value. The Japanese had an instrument which consisted of a knife blade, which was retractable, a collapsed thin tracheal dilator which easily followed the blade inward, and a dilator followed by a satisfactory tracheal tube. The Sheldon Riviera instrument used in California is said to have given good service. It is expensive, could not be made in quantity easily, and is now produced only in No. 6 size, which limits its use to adults. The fairly large, straight needle used would seem to be dangerous in any hands but those of an expert. We heard that it used a slot and guide, but worked out our own ideas before we saw it.

Our apparatus seems complicated, but really is not. A model made by V. Mueller and Company was presented in October before the Academy. It consists of a curved trocar and cannula with a slot widened at the top and in the anterior concave bend. The end of the trocar is sharpened laterally and rounded on the back. This is started at right angles through the trachea with the neck somewhat extended; then the handle is raised as the trachea is entered obliquely. The trocar is then withdrawn. At this point a small vinyl oxygen tube may be inserted. The cannula can then be withdrawn, the tube sectioned and held by a metal collar. A second in tandem could then be inserted. Temporary relief could thus be given to many patients in a very short time.

For the usual case, a No. 12 Bard Parker knife with the curved point ground nearly to the flat is guided along the slot by a bead brazed on the back of the tip, into the trachea. It is then inserted half way along the cannula and is pushed with the cannula into the trachea, making either one midline or two diagonal incisions. This is then removed, and a modified Jackson tube and obturator is inserted. This also may have a guide bead on its posterior face and a rounded blade set sagitally in its tip and projecting several millimeters forward. A slot permits removal of the armed obturator. After this is inserted, the original trocar cannula is withdrawn. If the original knife incision is made with a V tongue, insertion is easier. [A simple needle-type cannula with the curve of a tracheotomy tube and with a cutting edge and slot on the anterior concavity may replace the trocar and cannula.]

This device has worked well on the cadaver and on limited use in the live patient. The method is simple, rapid, and easy. Bleeding seems to give no trouble, since the fit is snug. If it should occur, it might be easily controlled by strip packing. If this should present a problem, we propose to adapt a taper Luer-type tube with springy side walls which might be expanded for pressure by insertion of the inner tube.

After the original tracheotomy tube with cutting trocar is withdrawn, a standard tube has been easily inserted. We hope that can be routinely done, so that only a limited number of tracheotomies will be required.

Discussion

Dr. Harold C. Lueth (by invitation): It is a real privilege and a pleasure to be invited to speak to you about something which has been of major concern to the medical profession, and it is most heartening that one of your very distinguished members is doing an important pioneer task in the field of emergency medical care.

If one looks at the whole problem of mass care under conditions of disaster, there are three major things that physicians must do to cope effectively with the task that confronts them. The first is to stop hemorrhage; the second to maintain an open airway, and the third to combat shock.

Depending upon the magnitude of the disaster and the circumstances under which men are expected to work, there are certain principles of mass disaster care that are not fully understood by the profession. It is regrettable that there has been a shift from the teaching of emergency medical care to the more definitive and later as-

pects of treatment. Even at the founding of the American Medical Association there was included among the aims of the organization a bettering of emergency medical care. Somehow through the years we have drawn away from this objective and have delegated emergency care to someone else. With the present state of the world tensions and the increase in technology, it is necessary that we again return to this problem. What Dr. Galloway said about nurses being qualified in these fields is true. All of us know this and seem to be reluctant to come to grips with the real problem of knowing and being able to do those things that will save life and limb. After all, it is a part of the medical approach to any problem of disaster, and one that must be included in future teaching and practice. We had better do a little revised thinking about how we can cope with the present situation—being faced in a disaster with too many patients, too little help, and too few supplies.

With the very ingenious instrument devised by Dr. Galloway, he has taken an important step in the right direction. It will enable many physicians to do a lifesaving tracheotomy with confidence under conditions of disaster. Perhaps all of us would do well to reassess our thinking in terms of how we can reduce the many things that we do in daily practice to simple terms so that they could be done by additional trained personnel. It is important that this type of thinking include those special fields and procedures of practice whereby all members not only of the specialty, but those in the general field of medical practice could do those essential life-and-limb-saving techniques that will so effectively enable the medical profession to cope with disaster. It will be seen at once that the opening of a safe airway may have to be done by other than a laryngologist in an emergency. The profession has a real obligation not only to teach its own members within a specialty field this technique, but to expand this type of teaching to the other portions of the medical profession. There are some who think that, to achieve the final results, these lessons will have to be taught to nurses and other members of the professional family, such as dentists and veterinarians. Even though we may be specialists in different fields, there is still the same primary objective of treating the whole man, and to accomplish this aim will require that we work closely with all other physicians, nurses, dentists, veterinarians, and others in the health fields. Naturally, before these lessons can be given the wide type of dissemination, the steps should be made as foolproof as possible.

Whether or not somebody drops an A-bomb or an H-bomb makes little difference to physicians. In either case there will be a larger number of casualties to be treated than the local medical profession can handle. After any of these detonations there will be large areas of damage. If you wish to review the size of the bombs and the damage done, it makes quite dreary mathematics. It has been stated by the President of the United States that one large H-bomb could take all of Manhattan Island. The real problem to doctors is providing care for the mass casualties that remain. It behooves us to learn how we can receive, screen, sort, and treat people carefully and speedily. Those that need immediate care must be seen by physicians at once and the necessary lifesaving procedures instituted at once. It is important that, even under conditions of stress, there be no waste motion and no loss of time. All things done for a patient must give the patient the best opportunity of finally coming back as a useful citizen. It is a new and gigantic task that will require the most careful and serious thought and action. This is our basic job, rather than that of worrying about the amount of physical damage that the thermonuclear weapons will do.

So, instead of leaving this meeting and thinking that you will do something about this later, please give this instrument some thought. While we still have time to study and use it, let us improve it and extend its use to many physicians. Give any suggestions you might have concerning this instrument, or any phases of emergency medical care, to other members of your profession. Try to help in getting over the need for an adequate airway with a minimum of danger or hazard.

I think I would prefer to leave it in that manner. I will be glad to attempt to answer any questions you might like to ask.

DR. G. HENRY MUNDT: Obviously we are living in a dangerous age. The instrument that Dr. Galloway has devised appears to be a very excellent addition to our armamentarium. That would be especially true in mass disaster. Many of us will try our old "life saver," or do a tracheotomy.

We are all negligent in our thinking about the hazards which possibly face us. We had better prepare ourselves mentally for mass disaster. We owe this to the general public and to the United States.

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY

The Effects of Smoking on the Upper Respiratory Tract. DR. LINDEN J. WALLNER.

There have been numerous articles in the literature on the medical aspects of smoking. These have included the chemical analysis of tobacco smoke, its results on experimental animals, and the local and systemic effects of smoking on various body systems. The larynx is the commonest site in the respiratory tract to present changes considered due to excessive smoking.

Alterations of the throat commonly attributed to smoking are (1) chronic nonspecific inflammation; (2) polypoid degeneration of the vocal cords; (3) leukoplakia, and (4) carcinoma.

Chronic nonspecific inflammation of the mouth, pharynx, and larynx is a very common disease and may be due to a number of different factors. Mouth breathing, hot spicy foods, alcohol, dry and dusty air, infection of the nose and sinuses may contribute to this condition. Subjective complaints may be absent, or include dryness and burning of the mouth and throat, postnasal discharge, hoarseness, and cough. The objective evidence of chronic inflammation is hyperemia, thickening of the mucosa and edema. Conspicuous evidence of chronic inflammation is commonly seen on routine examination of excessive smokers, with no other cause evident.

Histopathologic studies have recently determined that chronic inflammation of the respiratory epithelium is commoner in smokers. Ryan, McDonald, and Devine examined sections of 52 larynxes removed at autopsy. They were from men, 40 to 60 years of age, with no known laryngeal disease. In smokers there was greater thickness of the epithelium due to excess keratinization and hyperplasia. There was also more round-cell infiltration, edema and squamous metaplasia in smokers. Auerbach and co-workers made similar studies on the mucosa of the tracheobronchial tree of 41 patients. They also found basal-cell hyperplasia commoner in smokers.

Myerson studied 182 patients with polypoid degeneration of the vocal cords and concluded that it is a clinical entity directly due to smoking. He postulates that the irritation of tobacco smoke causes an outpouring of serum and then fibrosis, resulting in tumors that are edematous fibromata.

Leukoplakia.—Leukoplakia or keratosis is commonly seen in the mouth, tongue, pharynx, and larynx. Almost all observers list tobacco smoke as the chief factor in the etiology. The most important evidence of this is the fact that the condition is often reversible and will promptly clear up when smoking is stopped. A special papular type of leukoplakia occurs on the hard palate as described by Cummer.

Carcinoma.—The etiology of cancer remains an enigma, but chronic irritation is frequently listed as an important factor. It is a common observation that carcinoma of the larynx is often preceded by long periods of hoarseness. Many writers have emphasized the importance of precancerous lesions, especially leukoplakia, in the development of laryngeal cancer. It is thus obvious that if we accept smoking as an etiologic factor in keratosis we must also regard it as a factor in cancer.

Statistical studies also indicate the relationship of smoking to cancer of the respiratory tract. One of the most complete and detailed studies was recently reported by Wynder, Bross, and Day. One part of the study matched 209 patients with cancer of the larynx with 209 controls and 132 patients with cancer of the lung. Only one laryngeal cancer patient was a nonsmoker against 22 in the controls. They found that the relative risk of developing cancer of the larynx increased with the amount of tobacco consumed.

Kodachrome slides were shown illustrating chronic nonspecific inflammation, polypoid corditis, leukoplakia, and carcinoma arising in leukoplakia.

This review of recent literature plus clinical observations indicates that tobacco smoke contains irritating substances, resulting in inflammation of mucous membrane. Excessive smoking for long intervals commonly results in chronic nonspecific inflammation of the mucosa of the mouth, palate, pharynx, and larynx. This chronic inflammation may occasionally result in polypoid degeneration of the vocal cords or leukoplakia. The leukoplakia may be followed by cancer.

Since the serious diseases do not occur in a high percentage of smokers it may be argued that we are not justified in urging universal curtailment of smoking, a habit that seems to bring satisfaction to millions. But when a patient complains of symptoms or diseases described we should urge him to stop smoking, rather than prescribing sprays, gargles, or antibiotics. This requires a great deal more time and effort, and taxes the physician's powers of persuasion, salesmanship, and patience. He may be rewarded by the relief of the patient's symptoms as well as objective improvement in the disease.

Discussion

DR. PAUL E. STEINER (by invitation): So many points that merit discussion are made by this excellent paper that one hardly knows where to begin. Since the first cause of a human cancer was discovered by Percivall Pott in 1775, most of what is known on the etiology of tumors in man

has come from the careful observations of physicians.

It seems to be established that tobacco smoke produces pathological lesions in the larynx of some people. The case studies, statistical data, and the improvement reported to follow withdrawal are evidence in point. Because nonsmokers may exhibit the same four lesions, there must be multiple causes. The problem then becomes one of identifying these causes, and of determining the relative importance of each. Is tobacco smoke the principal cause or is it only one among others? To what extent, if any, do these causes summate their effects? Since many smokers do not have these lesions, is smoke effective alone or must some co-factor be present to raise it to a threshold dosage level?

Because there is no simple method for separating, identifying, and biologically testing these agents, the answers to the questions can only come by careful, critical, clinical studies which pay special attention to the environmental history, to statistical analyses, and to the effects of withholding the causative agent. In experimental chemical carcinogenesis in a given tissue, it is usually impossible to distinguish one agent from another by the resulting tissue changes and tumors.

To answer some of these problems, it would be desirable to examine a larger number of persons, divided into smoker and nonsmoker groups, but otherwise matched for sex, age, occupation, and general environment. Patients presenting themselves for medical care are not suitable for such a statistical study because they are already preselected by their symptoms.

Another problem concerns the relationship of these lesions. Does one evolve into the next, with time, if the cause continues to act on the cells? Assuming that they do, at what point, clinical and histological, do the epithelial changes become irreversibly destined to give rise to cancer? Is there a recognizable point, short of frank invasive carcinoma, from beyond which the cells cannot return to normal? These questions concern the interpretation of the basal-cell activity, cell atypias, and unrest, and the problem of carcinoma-in-situ in the larynx. The same problem exists also in other epithelia, especially those that are multilayered, as in the esophagus and the uterine cervix. At what exact point in epithelial abnormality to draw the line with confidence between harmless and harmful, only meticulous further studies will decide. The problem is difficult to study because removal of lesions for microscopical examination interferes with their evolution. Furthermore, results cannot be extrapolated from one species to another, in this instance from laboratory animals to man. It is known, for example, that some chemically induced animal tumors may regress if the chemical is withheld even after they have invaded.

Closely allied to the foregoing problem of the irreversibility of certain cellular changes is the question of the duration of the preinvasive period. Is the time from distinct basal cell abnormality to infiltrating cancer in the larynx always short, i. e., weeks or months, or may there be a long in situ stage lasting many years, as in some cases in the cervix? Is the lesion self-reversible during this time? This problem also can only be solved by long and careful observations in man.

What is the mechanism of action of tobacco smoke? Is it a direct effect of chemicals deposited on the epithelium or an indirect one from a rhinitis, sinusitis, or a bronchitis? Actually, it would be expected that the effects of these conditions, when present, would be additive.

Would the effect be one of specific carcinogens or might it result from a nonspecific damage? In my opinion it might well prove to be the latter. The great difficulties up to now in identifying known carcinogenic chemicals in tobacco tars, and then only in small amounts, speak for broad-spectrum effects. It has been a laboratory experience to find that carcinogenic activity, known to be present in a complex mixture, is lost when the fractions are tested separately. The whole has biological activity greater than its parts.

From the viewpoint of the human problem, the exact chemical nature of the offending agent may be unimportant. The questions are whether certain customs are harmful, and how harmful; if they are bad is the corrective measure to be modification of the custom, or its abolition?

If smoking is a carcinogen in the larynx, it must be a weak one. Of 100 babies born today, fewer than 1 will die from laryngeal cancers in the next 80 years according to present rates. Over half of these babies will become smokers, despite which the yield of serious growths will be small. This fact makes the problem difficult to study by epidemiological methods, and it explains the apathy of the public to the problem.

This matter is a problem in medical toxicology. It should be treated as any such problem. It is unfortunate that it is complicated by social and economic factors. The first problem is to determine the nature and degree of the health hazard. Only when this is known convincingly and beyond question can rational and acceptable recommendations be made on the broader, long-range, preventive and public health aspects. In the meantime this is a medical problem which each concerned physician should study, ponder, and treat according to his best opinion and the best advice he can muster.

Additional careful, long-term studies of the type here reported by Dr. Wallner are needed. From them eventually a factual, balanced picture of this hazard will emerge. From this sound basis, proper corrective measures will become apparent and possible. The laboratory can contribute general biological principles, but the final evaluation can be made only in this tissue and in the human species.

DR. ROBERT B. LEWY: This is, as usual, a very beautiful paper by Dr. Wallner. I wish I had given it myself.

I am a bit concerned about one feature of it where probably no concern is needed. It seemed to me there was a high percentage of carcinoma being found by pathologists, certainly higher than corresponding biopsies I had done. I wonder whether this was one pathologist, or a committee of two or three, who had a voice in making decisions as to whether carcinoma was or was not present.

I saw a patient with the far-advanced leukoplakia on both vocal cords. I did a direct laryngoscopy and found that both vocal cords were clean and free of leukoplakia and were only pink. I have been watching that patient month by month for a year, and apparently periodically he develops leukoplakia and then gets rid of it by some self-cleansing action. I wonder if Dr. Wallner has had a similar experience.

DR. PAUL H. HOLINGER: I certainly appreciate having an opportunity to hear Dr. Wallner's paper. One of the problems in this subject is the tremendous increase in the death rate of carcinoma of the bronchus, and in the increase in incidence of carcinoma of the larynx. We are making a big to-do about carcinoma of the bronchus and smoking; it becomes more and more obvious that carcinoma of the larynx and smoking are also related. Dr. Wallner mentioned some work we did some time ago on measurements of changes in the throat caused by smoking. Actually, very accurate measurements of color or blood-vessel size changes were almost impossible to determine. Measurements of the size of the blood vessels in the pharyngeal mucosa were made before and after smoking. This was considered one of the indications of inflammation. Yet we found the vessels changing so frequently normally that it was impossible to measure the changes in relation to smoking. Color changes, too, were unpredictable and did not follow a definite pattern following the smoking of a single cigarette. But, clinically, the chronic smoker has recognizable throat changes, and when we put these facts together we realize that a large number of persons have changes that ultimately go on to carcinoma. The dramatic change is most evident when such a patient stops smoking. The condition quiets down, the irritation disappears, and the process is seen to be reversible. Still, I believe there are 75% to 80% in this audience that continue to smoke.

DR. JOHN J. BALLENGER: I was interested in what Dr. Wallner said about Dr. Proetz' work because I have had confirmation of that work. I also wonder whether or not this is a factor which may make us more impressed with the effect of smoking on the larynx. The work of Dr. Proetz demonstrated the dispersion of smoke as it is blown through a glass tube which has some obstruction in it. The smoke is deposited just distal to this narrow spot. Confirmation of that work was in a youngster who had a cup of gasoline in his hand. It exploded and he inhaled the flame which was seen to come out of his mouth, so we were sure he had inhaled the flame. On laryngoscopy the only site of the burn was just distal to the vocal cord, in other words, the narrow spot. The flame had been concentrated in that area. If that is true, the narrow spot or constriction of the larynx will cause smoke or carbon to be deposited just distal to that constriction. The constrictions of the larynx occur primarily at the glottis, and so we may find the larger incidence of carcinoma in the subepiglottic space. I am not familiar with any work in which large numbers were involved. My impression is that they are not found in greater number in the subepiglottic area than above that.

DR. ARTHUR L. RATKO: Along with what Dr. Ballenger is saying, in the past six weeks I have personally seen seven carcinomas of the anterior pillar and tonsillar fissure. I was struck by this and by the frequency with which we have been seeing oral carcinoma in this particular area. In each instance it was quite easy to determine, since the lesion was early, that the lesion had originated on the free edge of the anterior pillar. In these cases, however, I wonder why the lesion occurs on the anterior face of the pillar when it should occur on the posterior aspect if the baffle-plate theory holds true?

DR. LINDEN J. WALLNER: I wish to thank the discussers. I am gratified that Dr. Steiner believes that these observations are of value in the study of cancer.

In answer to Dr. Lewy regarding the high percentage of carcinomas found, I did not intend to imply that leukoplakia leads to carcinoma in the frequency shown in the cases demonstrated. I chose illustrative cases to demonstrate how carcinoma does occur in leukoplakia. I believe that the pathologic diagnoses were accurate, and the slides were all studied by more than one pathologist.

I certainly agree with Dr. Holinger on the difficulties of interpreting the effects of smoking in the pharynx and larynx based only on the gross appearance and color. That is why I believe that Dr. Ryan's work is so important. He demonstrated objective histopathologic evidence of chronic inflammation in the larynx due to smoking.

Dr. Ballenger mentions that we should expect a high percentage of subglottic carcinoma, since the combustion products would be deposited beyond the true cords. Ryan discussed the clinical application of Proetz' experiments. The first constriction in the larynx is the false cords, and then the widening at the ventricles. In accordance with Proetz' findings, tars would be deposited just beyond the false cords, in the ventricle and on the true cords.

I do not know if the findings of Proetz would apply to Dr. Ratko's observation on the location of oral carcinoma.

Recent Advances in Diagnosis and Treatment of Conduction-Type Deafness: DR. HEINRICH G. KOBRAK (by invitation).

A Classification of Acoustic Prostheses.—A hearing prosthesis is defined as any device which replaces the function of a part of the sound-conducting system of the ear. An electric hearing aid is not a prosthesis because it functions on the principle of increased stimulation and not on the principle of improved ear function. One can distinguish three types of hearing prostheses: 1. Devices which close a perforation of the eardrum (ear drum prosthesis). 2. Prostheses which aim to replace a destroyed ossicular chain (ossicular prosthesis). 3. Devices which are attached to certain parts of the medial tympanal wall, mostly in the round window or stapes area (tympanal prosthesis).

The Ear Drum Prosthesis.—The functional pathology which is created by a perforation of the drum membrane is difficult to assess and should be carefully analyzed. More experimental investigations and good clinical analytical work are needed in order to clarify, in each single case, the individual factors responsible for the hearing loss. A careful and correct analysis is the first prerequisite for a successful therapy.

The following pathological conditions exist when the drum membrane has a perforation:

1. The area of the ear drum which collects sound energy and conveys it onto the malleus is diminished. The hydraulic ration is diminished.

2. Sound entering the middle ear through the perforation reaches both inner ear windows. The preferential sound conduction is reduced.

3. The round window membrane, which normally executes its vibrations toward an enclosed air space (tympanal cavity), is now vibrating against an open air space.

4. The intact ear drum acts like a baffle. A perforation of the membrane abolishes the baffle effect.

5. The perforation, according to its size, may act as an acoustic filter.

6. The effect of the tensor tympani is altered inasmuch as loss of some ear drum membrane makes the membrane softer.

No allowance has been made for the localization of the drum membrane perforation. Limited experimental evidence makes it plausible that the bioacoustic effect of a membrane perforation is stronger in certain peripheral drum areas than centrally. The baffle effect and the acoustic filter effect also require more elucidation by experimental studies.

For clinical purposes it seems safe to say that the loss of area is the most outstanding physical reason for the hearing impairment, and, consequently, the artificial ear drum acts mainly by the restoration of ear drum area. Direct observations with macroscopic stroboscopic cinematography have shown that the materials used as "artificial ear drum" vibrate in phase with the rest of the tympanic membrane. All the biophysical abnormalities caused by the ear drum membrane perforation and enumerated above are reversed. It is, therefore, not astounding that patients whose pathology consists solely of the perforation attain completely normal hearing by the fitting of an ear drum prosthesis.

Experimentally it was tried to ascertain the effect of size and site of membrane perforations. We utilized fresh cadaver ears in preference to animals because we feel that apparently there is still great but unrecognized difference between the physical characteristics of the mammalian sound conduction system and that of man. Fresh cadaver ears were used in the study of artificial drum membrane perforations. It is possible to produce any size, shape, or site of perforations by burring holes into the tympanic membrane of the cadaver ear. The difficulty in utilizing fresh temporal bones lies in ascertaining the function before and after the lesion. There is no cochlear potential and no muscle reflex in a cadaver ear. However, we do believe that we have a method by which functional tests can be performed in the cadaver ear. This method consists in observing and measuring the acoustic vibrations of the inner ear fluid. In the European literature Link has used this method also. When a reversible middle ear lesion is created while a steady tone is given and while the oscillations in the inner ear are being observed, then a change of amplitude of the inner

ear fluid movements can be readily seen. From these experiments we come to the conclusion that the periphery of the ear drum creates greater functional loss than the same size and shape perforation in the center parts.

There are patients in whom the same technique is followed but no functional gain is observed when such an artificial ear drum is placed. While the successful patients are gratifying, the second half of the unimproved patients present a much greater challenge and demand greater interest. One has to analyze why the failures occurred. The over-all explanation most likely is that patients who fail to benefit are those who, in addition to the perforation of the ear drum membrane have additional pathological changes which are not recognized because they are located in invisible places of the tympanic cavity.

The Tympanal Prosthesis.—Physiological considerations: The loss of ear drum, and of the two lateral ossicles as found in advanced chronic middle-ear infections and in a radical mastoid cavity, represents the following abnormal conditions of sound conduction:

1. The normal impedance matching accomplished by the ear drum and the ossicular chain is no longer present.

2. The preferential sound conduction to one inner ear window by the ossicular chain is abolished.

3. The two windows face the sound source and execute vibrations with nearly equal phase instead of opposite phase as in normal sound conduction.

4. The round window membrane does not face an encased air bubble but an open air space. The vibratory phenomena in the cochlea, especially the dampening, may be influenced by this condition.

5. The sound conduction system represents a mass which is in direct contact with the cochlea. The loss of the ear drum, malleus, and incus diminishes this mass.

6. The effect of the tensor tympani muscle is lost.

7. The effect of the stapedius muscle is changed. The stiffness of the stapes alone is smaller than the stiffness of the intact ossicular chain. Visible motions of the stapes are observed during contraction, which do not occur on the intact chain.

At the present time it is impossible to assess these physical factors in diseased ears as to their individual role in causing the hearing loss.

Of all the bioacoustic factors enumerated in the list, most important is that both windows are facing the sound waves. The preferential conduction of sound to the oval window, which is normally accomplished by the ossicular chain, is not present in such an ear; the opinion was brought forward long ago that some material brought into the round window niche acts as a screen and keeps the sound energy from reaching the round window membrane. A very characteristic term has been used for this procedure. It has been said the round window is placed into "sound shadow." Prerequisite for the condition is that a bubble of air be left between the cotton pellet and the membrane of the round window. According to this concept, the air bubble will permit excursions of the membrane during acoustic stimulation of the ear but prevents the sound from reaching the round window directly. The clinical evidence as to the effectiveness of a moist cotton pellet is convincing. However, the interpretation as a sound shadow is not absolutely clear on physical grounds.

The cotton pellet is also effective if no air is left in front of the round window membrane. If a drop of oil or mercury is placed straight against the membrane, a good hearing improvement is obtained also. Furthermore, if the foreign body is placed against the stapes, a similar hearing improvement is found. It is evident that the physical conditions in such a case are different from the "sound shadow" effect. The physical effect of the pellets is the same on either stapes or round window membrane. It acts like an increase of the mass factor.

Discussion

Dr. Robert Henner: It is a very difficult task to open the discussion of a paper such as Dr. Kobrak has presented because how does one argue or discuss fundamental physiology such as he always presents so beautifully? I made a few notes ahead of time because of the knowledge of the subject matter. I want to point out some of the additional observations of my own on this presentation on physiology of the middle ear. Again I want to state that Dr. Kobrak deserves great praise because his interest in middle-ear physiology is always timely.

The development of modern temporal bone surgery aided by the use of the microscope and antibiotics allows more and more concentration on the functional aspects of the ear rather than concern for life. For this reason, any improvement in diagnostic technique and knowledge of physiology is the more timely. The use of the acoustic probe serves as an important diagnostic tool in determining preoperatively whether tympanoplasty should be successful. It is also possible to determine continuity of the ossicular chain, and mobility of the stapes in chronic suppuration. This will aid in deciding whether there is promise of doing an atticomastoidectomy with a fenestration type flap for maximal hearing, or whether tympanostapedopexy with a graft will be necessary. Zollner and Wullstein have pioneered this functional surgery in recent years, and Gisselsson has used the acoustic probe diagnostically.

I might state that we have had an acoustic probe of the type that Dr. Kobrak has described to you made by Beltone. We have used it only for one week, so our observations in this direction are relatively recent. However, we have learned one thing well, and that is that the volume should be turned as low as possible. This acoustic probe that Dr. Kobrak describes is plugged into the bone conduction outlet of the audiometer. We have used it by bringing our operating light into the hearing room. When the volume is at its lowest, it is easier for the patient to determine changes in volume with your field exposed. Relative volume reception at the bony canal, short process of the malleus, stapes, and round window areas are compared. This helps us to decide whether we should add stapedopexy or whether tympanoplasty should be done for better hearing.

A recent patient scheduled for surgery with a moist attic cholesteatoma and only 25 db. air loss and normal bone conduction shows interruption of the ossicular chain and indicates the probability of the need for stapedopexy. Of course, surgery will finally determine the extent of the pathology, and I would like to stress the primary responsibility of eradicating disease to avoid later complications and the progression of the hearing loss.

I made a few notations pertinent to some of the factors of columella physiology that Dr. Kobrak mentioned. It is quite likely that the human ear ossicular chain has protective value as well as sound conduction function. We have seen patients who had fenestration operation and were exposed to loud noises who need acoustic protection. There is no way in fenestration of regaining the damping action of the stapes. It is quite probable that using the artificial columella in cases where the crura are eroded during radical ear surgery may offer improved hearing. We intend to study this further.

Two points seem worth emphasizing:

1. Surgery for chronic suppurative temporal bone disease is making strides forward toward conservation of hearing, but this does not mean routine improvement. Frencker reported 30% results in cholesteatoma and better results in simple suppurative processes. Our own results are usual improvement when the impedance of large polyposis of the middle ear is removed as part of mastoidotympanectomy and grafting, but about the same percentage as Frencker's in cholesteatoma. In fact, with extensive perilabyrinthine disease, partial deterioration of the eighth nerve occurs occasionally, and the hearing may be further depressed postoperatively.

2. I would personally like to state that there is need for more teaching of temporal bone surgery. As the diagnostic techniques improve and the successes of meticulous restorative surgery are reported, so do younger surgeons become stirred beyond the limits of their capabilities. As a teacher, I feel a direct responsibility to make students aware of their limitations and to provide the means for improving them.

Again I wish to thank Dr. Kobrak for his stimulating presentation.

Abstracts from Current Literature

Ear

THE TECHNIQUE OF PLASTIC OPERATIONS ON THE SOUND CONDUCTING APPARATUS. F. C. ORMEROD and K. MCLAY, J. Laryng. & Otol. 70:648 (Nov.) 1956.

A comprehensive review of the sound-conducting mechanism of the ear is presented. This is followed by a diagrammatic discussion of the disturbed physiology produced by perforations of the tympanic membrane, interruption of the ossicular chain, and partial occlusion of the round window. Before undertaking any reparative measures for restoration of function, all infection in the middle ear must be eliminated. The status of the ossicular chain must be ascertained. This is accomplished with the acoustic probe by applying it to the handle of the malleus, the stapes, and the promontory. The surgical procedure depends entirely on the type of perforation of the tympanic membrane and the condition of the ossicular chain. A diagrammatic description of the techniques used for closure of perforations and for the restoration of the conducting mechanism is presented. This meticulous dissection can only be accomplished with the use of the operating microscope and proper illumination. The gratifying results obtained warrant the time and care required in this delicate and meticulous dissection.

LEJEUNE and BEATROUS, New Orleans.

AN EVALUATION OF THE PSYCHOGALVANIC SKIN-RESISTANCE TECHNIQUE IN AUDIOMETRY. J. E. BORDLEY, Laryngoscope 66:1162 (Sept.) 1956.

Standard hearing tests, which depend upon subjective responses, are unsuitable for both the very young child and the adult suffering from psychic trauma or brain damage.

Several methods have been employed to determine the hearing in young children. They are as follows: (1) the use of various noise makers, (2) speech audiometry, (3) play audiometry (peep show), and (4) changes in the electroencephalogram with a test tone. The relative merits and disadvantages of these tests are discussed.

For cases in which the above techniques are unsatisfactory psychogalvanic skin-resistance audiometry was developed. The technique whereby the patient is conditioned to a shock following a tone is described. This is an end-organ test; there may be no mental comprehension or hearing as we know it. The accuracy as compared with standard audiometry is good and, in most cases, lies within 5 db. The test can be done on children as young as 18 months; younger than this, the results are not nearly as accurate. A well-trained test team is most important to secure good results. This test is of diagnostic aid in persons with certain types of brain lesions. They are usually intelligent, elderly people. They have poor standard audiograms and poor discrimination. They feel that they hear well. Their psychogalvanic skin resistance is good. Diagnostically this means a good end-organ but damage to the higher auditory pathways, probably cortical.

Uses of the test in other groups, not suitable for standard tests, are suggested.

HITSCHLER, Philadelphia.

REPAIR OF CHRONIC CENTRAL PERFORATIONS OF THE TYMPANIC MEMBRANE: BY REPEATED ACID CAUTERY: BY SKIN GRAFTING. WILLIAM K. WRIGHT, Laryngoscope 66:1464 (Nov.) 1956.

This is a very complete and well-composed article on closure of central tympanic perforations.

Cauterizations with 50% trichloroacetic acid are applied weekly. A cotton pack, continuously wet with neomycin drops, is kept against the drum between treatments. There should not be a longer time interval between treatments or growth-stop closure may take place in a few weeks; it may be delayed for as long as one to two years. Of 65 perforations, 57 were closed by this method.

Skin grafting is another method of closing perforations. Under thiopental (Pentothal) sodium anesthesia, the outer layer of squamous epithelium is peeled off the drum membrane about the perforation, and sometimes from the canal wall as well. If vision is limited, it is

best to make an endaural incision similar to that used in a mastoidectomy, make a flap, and enlarge the bony-canal wall as necessary; or the anterior canal wall can be curetted without elevating the skin.

HITSCHLER, Philadelphia.

NYSTAGMUS IN MÉNIÈRE'S DISEASE DURING ATTACKS: A NYSTAGMOGRAPHICAL STUDY. G. ASCHAN and J. STAHLE, Acta oto-laryng. 47:189 (March) 1957.

This article represents a nystagmographical study during the presence of vertigo in 21 cases of idiopathic Ménière's disease. Nystagmus was found to be always present during the attack. It varied in character. The commonest forms were direction-fixed positional nystagmus and true spontaneous nystagmus. Nystagmus of direction-changing type was found to be present in one-fourth of the cases. The character of the nystagmus was not necessarily constant and changed during attacks of long duration.

In the period between attacks it was usually possible to demonstrate a diminished caloric response on the affected side. The variability of the character of the nystagmus suggests that the etiology of the condition is not uniform. The basic contribution is the demonstration in these experiments which illustrate that, by means of nystagmography, the results of calorization can be judged, showing variations in the amplitude and number of beats even if nystagmus is present before the application of the caloric stimulus.

LEWY, Chicago.

TECHNIQUE OF SURGICAL REPAIR OF THE MIDDLE EAR—TYMPANOPLASTY. JUAN MANUEL TATO and GONZALES DE SIBASTIAN, Acta oto-rino-laring. ibero-am. 8:65 (Jan.) 1957.

The authors discuss the many problems of middle-ear infection and the late influences on impaired hearing. They stress the importance of closure of the perforation of the tympanic membrane and the use of various types of grafts and skin flaps. The indications for the various procedures depend on the extent of the underlying pathology. Accordingly, their routine follows the plan outlined by Wullstein and Zollner. They give their indications for each procedure, the various methods of approach, and their results.

Summarizing their findings, it is apparent that (1) it is not unusual for the hearing to become worse after surgery, (2) although hearing may not be improved, a clean, healthy tympanic membrane is produced, and (3) the chances for improvement of the hearing are greater by this procedure than by the classical radical operation. Hence the latter methods should be abandoned in favor of these newer techniques.

PERSKY, Philadelphia.

TREATMENT OF LABYRINTHINE VERTIGO—THE POSTERIOR FOSSA ROUTE. J. PIQUET and G. DECROIX, Ann. oto-laryng. 73:909 (Dec.) 1956.

The authors present a different approach to the surgical management of Ménière's syndrome. With the use of refrigeration anesthesia, a retroauricular incision is made. The mastoid process is exposed and sufficient cells are exenterated to expose Trauttmann's triangle. This is cleaned out; the lateral sinus plate is removed, and the posterior fossa is entered. Approximately 6 cm. of bone is removed in this area. The wound is then closed.

Twenty patients were reported. There were 7 cures, 4 improvements, and 1 failure in the first group of 12 patients.

The authors believe that their procedure is superior to (1) the opening of the endolymphatic sac; (2) opening of the dura mater, or (3) drainage of the cerebrospinal fluid through the mastoid. In their experience, the simple decompression of the posterior fossa has yielded very favorable results.

PERSKY, Philadelphia.

FUNCTIONAL SURGERY OF INFLAMMATORY OTITIS MEDIA. M. PORTMANN, G. CLAVERIE, and E. CHAUVAC, Rev. laryng. 77:1009 (Nov.-Dec.) 1956.

Surgery of the middle ear must necessarily be directed toward eradicating all infection and all dangers of complications. In addition, much thought should be given to preserving good auditory function. These principles apply to (*a*) simple chronic suppurative otitis media, (*b*) chronic suppurative otitis media with cholesteatoma, and (*c*) after-effects of otitis media.

The authors present the following fundamentals for their choice of surgery: (1) the establishment of a membrane to maintain a difference of air pressure between the stapes and

the oval window; (2) a columella effect; (3) provision for a compensatory play between the two windows, and (4) the need for a balance of pressure on all parts of the vibrating membrane—hence a patent Eustachian tube.

There is no one type of operation that will satisfy all conditions. The authors employ (*a*) a simple tympanoplasty, (*b*) a radical operation plus a tympanoplasty, or (*c*) a radical operation. The choice of procedure rests on the underlying pathology.

In 16% of cases the tympanoplasty has failed and the perforation has recurred.

PERSKY, Philadelphia.

Larynx

A METHOD OF RESTING THE VOCAL CORDS. J. J. CANTOR, Laryngoscope 67:157 (Feb.) 1957.

Cantor presents an ingenious approach to the problem of rest for the diseased vocal cord. An artificial conductive deafness (of about 20 db.) is produced by ear plugs. As is known, a person with a pure conductive deafness tends to lower his voice. This, of course, helps rest the vocal cords. The patient is still able to hear others, for they unconsciously raise their voices well above the ambient noise level. Other people will be able to hear the patient if he comes near them and enunciates clearly, which he will probably do. However, even if the patient is not heard distinctly, his vocal cords will be spared, this being the purpose of the ear plugs.

HITSCHLER, Philadelphia.

THE USE OF TRACHEOTOMY IN THE BURNED PATIENT. T. C. NELSON, R. D. PILLSBURY, and W. F. BOWERS. Surg. Gynec. & Obst. 104:163 (Feb.) 1957.

The authors analyze their experiences with 64 patients on whom tracheotomy was performed in a series of approximately 1000 hospitalized burned patients at the Brooke Army Hospital. Clinically, the operation was performed in the presence of respiratory embarrassment, to prevent secretional obstruction, for respiratory tract irritation, to aid in anesthesia, as a prophylactic measure in deep facial burns, and for associated injuries. In nearly every instance the need for tracheotomy was occasioned by the presence of deep face and neck burns or respiratory tract involvement. If early tracheotomy is performed upon the recognition of either of these two types of burn involvement, the other indications seldom arise as the initial clinical reason for using this procedure. The incidence of avoidable complications associated with tracheotomy is sufficient to warrant careful attention to every aspect of technique and after-care. Particular attention should be given to the size and fit of the cannula, to humidification of inspired air, and to proper aspiration of tracheobronchial secretions. One important step in increasing the ease of all aspects of after-care is the use of the technique of tracheotomy in which a portion of the anterior tracheal wall is excised. This technique provides a safer airway in case the tracheotomy tube is dislodged, or if it needs to be replaced with another cannula, a bronchoscope, or an endotracheal tube.

Of particular interest was the use of tracheotomy to facilitate anesthesia in 19 patients who had full-thickness burns of the face. The tracheotomy tube provided a simple, safe, and accessible route for endotracheal anesthesia, and some of the patients underwent anesthesia in this manner as many as 15 times. This particular use for tracheotomy offers several advantages in the management of a patient with burns of the face. The surgical field is free from anesthetic equipment; the danger of increasing damage to the burned surface from pressure or irritation is avoided, and the hazard of applying an anesthesia mask over face grafts or a recently healed burn is minimized. Additionally, intubation is simpler via the tracheotomy opening, particularly when contractures about the mouth offer difficulty in oral insertion of an endotracheal tube. Furthermore, difficulties from aspiration following anesthesia are greatly lessened.

As mentioned above, the basic steps and proper after-care of tracheotomy are emphasized and are particularly important in dealing with burn cases.

ABSTRACTER'S COMMENT: With the widespread use of antibiotics and the development of antibiotic-resistant strains of bacteria among hospital personnel, the meticulous and aseptic care of tracheotomized patients needs emphasis. The development of fatal tracheobronchial and pulmonary infections caused by antibiotic-resistant strains is one of the increasing hazards in the widespread use of tracheotomy, and the universal employment of antibiotics.

FRIEDBERG, Chicago.

PAPILLOMA OF THE LARYNX. HARRY BJORK and CHRISTIAN WEBER, Acta oto-laryng. 46: 498 (Nov.-Dec.) 1956.

This article is a report on papilloma of the larynx, incorporating 117 cases. These cover the period from 1930 to 1955. Primary malignant papillomas were not included. Sixty-one per cent of the patients were males and the remainder females. Cases of papilloma were commoner during and immediately after the War. Since 1950 the incidence has been much lower in children. The high incidence during bad times was interpreted as being due to poor social and hygienic conditions. Seventy-one per cent of the cases presented a family history of warts. Puberty did not influence the course of the condition. Malignant change occurred in only two of the cases. The first sign of malignancy was limitation of mobility. Therapeutic excision is a valuable form of treatment. Cauterization did not reduce the tendency to recurrence. Tracheotomy was performed in 8%. Papilloma of the larynx in adults differs in many respects from papillomatosis in children, and it is believed that the diseases are of essentially different natures in the two groups.

LEWY, Chicago.

Pharynx

THE PROBLEM OF POST-TONSILLECTOMY POLIOMYELITIS: AN ANALYSIS OF 888 CASES OF POLIOMYELITIS AND 2813 TONSILLECTOMIES FROM A DISTRICT IN THE SOUTHWEST UNITED STATES, 1949-1953. CHARLES E. ENGELKING, Laryngoscope 66:1541 (Dec.) 1956.

This is a very comprehensive and complete article. It reviews and evaluates the literature on the subject. It also records the tonsillectomy-poliomyelitis statistics from 1949 to 1953 in a community in the southwestern part of the United States.

Many articles on this important subject are mere expressions of the writers' opinions, often derived from others' experiences, and often add little or no statistical evidence of their own. Sometimes poorly analyzed statistics confuse the picture. A. H. Miller's and J. R. Page's contributions are of real value. The former pointed out that the rate of poliomyelitis after tonsillectomy seems to follow the rate of tonsillectomy in the general population, but bulbar poliomyelitis appears more frequently in the tonsillectomized patients. The results of many more surveys are recorded. Their conclusions vary greatly. Numerous other factors, such as other operations, e. g., tooth extraction, stress and strain, and general health have to be taken into consideration. Many essayists believe that these other factors, and not tonsillectomy itself, have most to do with the development of poliomyelitis. Also the latter group in general are those who have studied larger series of cases, and whose statistical analysis has been sounder. The study by the author of 888 cases of poliomyelitis and of 2813 adenotonsillectomies in the Southwest United States confirms this opinion. Only 2 cases of poliomyelitis developed in the 788 patients whose tonsils status could be determined.

HEITSCHELER, Philadelphia.

Nose

CORRECTIVE SURGERY OF THE NASAL TIP. JOHN MARQUIS CONVERSE, Laryngoscope 67:16 (Jan.) 1957.

This is a most comprehensive article on surgery of the nasal tip in connection with corrective nasal plastic operations. In many such operations, where the profile is modified, the nasal tip must also be modified in order to produce a satisfactory result; otherwise a "parrot beak" profile, a drooping of the tip, or a convexity in the area above the tip may result. Detailed explanations with illustrations explain the various methods and techniques recommended for the proper handling of the tip. Included are the modified technique influenced by Joseph, Safian's technique, the retrograde, the hockey-stick incision technique, and others. Several exposures of the alar cartilages are explained. A new tip remodeling operation is presented. A minimal amount of cartilage is resected in this procedure. It is well suited for the broad, slightly bifid type of nasal tip. Also a new technique for correction of the wide columella is described. The medial crus on each side is exposed, the skin elevated, and the intervening tissue removed. Subcutaneous sutures are placed holding the crus together. In this way the irritation caused by the usual mattress sutures through the skin is avoided.

Many types of deformities of the tip and their correction are described.

HEITSCHELER, Philadelphia.

Miscellaneous

TONSILLECTOMY AND ADENOIDECTOMY: AN ANALYSIS OF A NATIONWIDE INQUIRY INTO PREVAILING MEDICAL PRACTICES. IRVING J. WOLMAN, Quart. Rev. Pediat. 11:109 (Aug.) 1956.

The pediatricians' attitude toward the removal of tonsils and adenoids was evaluated by a questionnaire sent to 10,200 practitioners specializing in childhood diseases. There were 3441 replies.

Indications. There was a remarkable unanimity of opinion (100%) that recurrent or chronic otitis media requires adenoidectomy, usually with tonsillectomy.

Most pediatricians agreed (86% to 88%) that surgery is helpful in relief of mouth breathing or snoring for recurrent or chronic tonsillitis and for early hearing impairment.

Shall these structures be removed separately or simultaneously? Of the respondents, 28 felt that simultaneous removal should be done. One practitioner with 20 years' experience stated that more than 90% of his patients in whom only adenoidectomy was done later required removal of adenoids and tonsils.

The median age for surgery was 6.4 years.

Is there a best time of year? The popularity of the period between November and April, with a decline during spring, summer, and early fall, reflects the current fear of precipitating poliomyelitis by nose and throat surgery during the latter time.

Pre- and postoperative treatment. The replies were probably of little value, since most of the respondents do not perform the operations themselves.

Relationship between poliomyelitis and tonsillectomies and adenoidectomies. The opinions vary from one extreme to the other. One observation pointed out that the increased incidence of poliomyelitis in tonsillectomized patients may be simply a reflection of a constitutional susceptibility to infection. The child who requires a tonsillectomy is probably also susceptible to poliomyelitis.

Severe complications. About one death per thousand yearly operations is reported. The mortality rates are about as follows:

Anesthesia	60%
Postoperative hemorrhage	28%
Sudden death within a few days postoperatively	12%

Severe complications, such as late hemorrhage, pneumonia, and septicemia, occur in about 14 cases per 1000 a year.

Are there any persistent emotional changes following operation? In 74% of the replies it was stated that these occur rarely or occasionally and that they never occur in about an additional 12%.

Effects of operation. There was a 95% or greater improvement in patients operated upon for the following conditions: mouth breathing, snoring, hearing impairment, otitis media, or cervical adenitis. There was a 60% to 73% improvement in cases of sinusitis, bacterial pharyngitis, lung infections, and asthma. Only about 45% of those operated upon for recurrent colds improved. Other nonspecific benefits were mentioned in many cases, such as weight gain, increased appetite, and improved growth.

The survey revealed a high percentage of disagreement among practicing pediatricians on the necessity for tonsillectomy and adenoidectomy since antibiotics and radiation therapy have proved effective. The article is enlightening and furnishes the otolaryngologist an interesting opportunity of seeing the problem from a different point of view.

KIRCHNOR, New Haven, Conn.

Books

Die Ortho- und Pathobiologie des Labyrinthes als Grundlage der dystonischen und dytrophischen Erkrankungsprozesse des Innenohres. By Karl Wittmaack, Professor Emeritus and Director, of the University Ear, Nose, and Throat Clinic, Hamburg. Edited by Heinz Rollin, Professor, University of Hamburg. Price $8.90. Pp. 294, with 189 illustrations. Georg Thieme, Stuttgart, Verlag, Herdweg 63(14a), Stuttgart (American Agent—Grune & Stratton, Inc., 381 4th Ave., New York 16), 1956.

Wittmaack is one of the famous writers on the labyrinth of 50 years ago. He was a contemporary of Neumann, Ruttin, and Alexander in Vienna and of a great group in other university centers. In this book, edited by Rollin, it is the primary object to describe the normal pathology and physiology of the inner ear, then to study intensively the pathology of the diseased or aberrant labyrinth. Thus it is a treatise on microbiology of the inner ear. The amount of effort and the years required to bring forth this great work cannot be told, although Wittmaack states that he has been investigating the subject for 45 years! To him, as a very old man, this completed text doubtless gives a thrill. It should, since it is authoritative, detailed, and scholarly in every respect. Nothing completely new can be offered, of course, save the interpretation of one's own findings in comparison with the author's. We see very few cases of labyrinthitis in America. In general, the diagnosis is easy. There is no "treatment" save for ablation of the labyrinth when it is diseased beyond restoration and is a menace to life. Ménière's disease we still see, not infrequently. In spite of recently devised operations by I. Rosen and other surgeons, it is still baffling. Some authors connect it with allergy as a special manifestation.

It seems unfortunate that no index is provided in this otherwise excellent work, but the table of contents helps somewhat in this regard.

Lehrbuch der Nasen- und Halsheilkunde und der Endoscopie der Speiseröhre und der Luftwege. Dr. Erhard Luscher, Ordentlicher Professor der Ohren-Nasen-und Halsheilkunde, Direktor der Universitätsklinik und Poliklinik für Ohren-Nasen-und Halskranke in Basel. Price (Cloth Bound) $23.35. Pp. 629, with 249 illustrations. Wein, Springer-Verlag., 1956.

As one would expect from a German author, here is a highly specialized text on nose and throat disease and conditions. Anatomy and physiology are detailed, and pathology is fully described. Many photographs, diagrams, and plates illustrate the reading matter. A special chapter deals with the pharynx in all three divisions, roughly 150 pages, and describes every possible ailment from tumors benign and malignant, to gangrene of the tissues within and without the neck. In various chapters, diseases of the skin which become diseases of the mucous membrane are discussed, such as pemphigus and erythema multiforme, also those mouth and pharyngeal conditions which yield to broad spectrum antibiotics. Fungus conditions are dealt with.

The author is a "direct-tube" enthusiast and recommends direct tube examination in such conditions as bronchial asthma. In America, we have a feeling that we sometimes make such a condition worse by the ordeal of bronchoscopy, although its uses are to be sure, paramount in many instances.

One might expect much more concerning the antibiotics. While these are mentioned in various pages, there seems to be no great enthusiasm on the part of the author for their daily use, such as we advocate in this country.

Unlike many other German texts, not many references are made to "the literature." There are few footnotes. This writer, Luscher, is an authority, and maintains his status throughout his text.

Oto-Rhino-Laryngologie Infantile. By A. Lemariey, Otorhinolaryngologist to the Hospital of Paris and H. Muller, Assistant Otorhinolaryngologist to the Hospital of Paris. Price, 5400 Fr. (paper); 6200 Fr. (cloth). Pp. 826, with 300 illustrations. Masson & Cie, 120 Boulevard Saint-Germain, Paris 6e, 1957.

The purpose of this book is to establish a closer correlation between the otolaryngologist and the pediatrician.

Routine examinations, normal appearances, developmental anomalies, pathologic status, and their relation to symptomalogy are presented in great detail. Treatment, both medical and surgical, is described and amplified by both formulae and illustrations. The antibiotics are considered in detail.

The first section deals with the nasal fossae. This includes choanal atresia and stenosis; nasal fractures, cysts of the nasal fossae and septum; acute and chronic rhinitis—their etiology and relation to the infectious and contagious diseases, the various tumors that may occur, and epistaxis.

The second section deals with the sinuses.

The third section presents a consideration of the pharynx. The discussion deals with malformations, diverticulae, fistulae, foreign bodies, acute and chronic tonsillitis; specific infections, such as diphtheria, scarlet fever, infectious mononucleosis, tuberculosis, and syphilis, and the various new growths, both benign and malignant.

The larynx and esophagus are similarly discussed in the succeeding sections. The last section deals with the ear and mastoid and their many problems including deafness.

The book is well written, clearly presented, and is most comprehensive. It is practical and should be well received by both the otorhinolaryngologists and the pediatricians.

News and Comment

GENERAL NEWS

British Columbia Oto-Ophthalmological Conference.—The first British Columbia Oto-Ophthalmological Conference was held in Vancouver, May 22-25, 1957, and was well attended by doctors of the Pacific Northwest. Sir Victor Negus of London, England, gave several lectures ("The Mechanism of the Larynx," "Tracheostomy," and "The Function of the Paranasal Sinuses") and showed a number of interesting films. The guest speaker for the ophthalmological section was Dr. Alston Callahan, of Birmingham, Ala.

Directory of Otolaryngological Societies *

FOREIGN AND INTERNATIONAL

Canadian Otolaryngological Society
(Société Canadienne d'Otolaryngologie)

President: Dr. G. M. T. Hazen, 208 Canada Building, Saskatoon, Sask.
Secretary: Dr. G. A. Henry, 328 Medical Arts Building, Toronto.

Venezuela Otorhinolaryngology Society

President: Dr. Alfredo Celis Pérez.
Secretary: Dr. Jesús Miralles.

International Bronchoesophagological Society

President: Dr. Theodor Hünermann, Düsseldorf.
Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.

International College of Surgeons, Section of Ophthalmology and Otolaryngology

President: Dr. Henry M. Scheer, 522 W. End Ave., New York 24.
Secretary: Dr. Louis Savitt, 3402 W. Lawrence Ave., Chicago 25.

International Congress of Audiology

General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Netherlands.
Place: Leyden, Netherlands.

International Course in Paedo-Audiology

General Secretary: Dr. H. C. Huizing, 182 Oostersingel, Groningen, Netherlands.
Place: Groningen, Netherlands.

Pan-American Association of Oto-Rhino-Laryngology and Broncho-Esophagology

President: Dr. José Gros, Havana, Cuba.
Secretary: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.
Meeting: Sixth Pan-American Congress of Oto-Rhino-Laryngology and Broncho-Esophagology.
Place: Brazil. Time: 1958.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. Alden Miller, 500 S. Lucas Ave., Los Angeles.
Secretary: Dr. Hugh A. Kuhn, 112 Rimbach St., Hammond, Ind.
Place: San Francisco. Time: June 23-27, 1958.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Erling W. Hansen, 90 S. Ninth St., Minneapolis.
Executive Secretary-Treasurer: Dr. William L. Benedict, 100-1st Ave. Bldg., Rochester, Minn.

American Board of Otolaryngology

President: Dr. Gordon D. Hoople, 1100 E. Genesee St., Syracuse 10, N. Y.
Secretary-Treasurer: Dr. Dean M. Lierle, University Hospitals, Iowa City.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.

American Broncho-Esophagological Association

President: Dr. Walter Hoover, 605 Commonwealth Building, Boston.
Secretary: Dr. F. Johnson Putney, 1719 Rittenhouse Sq., Philadelphia 3.
Place: Mark Hopkins Hotel, San Francisco. Time: May 21-23, 1958.
Place: The Homestead, Hot Springs, Va. Time: March, 1959.

American Laryngological Association

President: Dr. Harry P. Schenk, 326 S. 19th St., Philadelphia 3.
Secretary: Dr. James H. Maxwell, University Hospital, Ann Arbor, Mich.
Place: Fairmont Hotel, San Francisco. Time: May 19-20, 1958.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. Lawrence R. Boies, University Hospital, Minneapolis 14.
Secretary: Dr. C. Stewart Nash, 700 Medical Arts Bldg., Rochester 7, N. Y.
Place: Mark Hopkins Hotel, San Francisco. Time: May 21-23, 1958.
Place: The Homestead, Hot Springs, Va. Time: March, 1959.

SECTIONS:

Eastern.—Chairman: Dr. Chevalier L. Jackson, 3401 N. Broad St., Philadelphia 40.
Place: Hotel Warwick, Philadelphia. Time: Jan. 9-10, 1958.
Southern.—Chairman: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis, Tenn.
Place: Peabody Hotel, Memphis, Tenn. Time: Jan. 25-26, 1958.
Middle.—Chairman: Dr. Francis L. Lederer, 860 N. Lake Shore Drive, Chicago.
Place: Hotel Morrison, Chicago. Time: Jan. 13-14, 1958.
Western.—Chairman: Dr. Ben. R. Dysart, 960 E. Green St., Pasadena 1, Calif.
Place: Beverly-Hilton Hotel, Beverly Hills, Calif. Time: Jan. 18-19, 1958.

American Rhinologic Society

President: Dr. Walter E. Loch, 9 Beechdale Rd., Baltimore 10.
Secretary: Dr. Robert M. Hansen, 1735 N. Wheeler Ave., Portland, Ore.

American Otological Society, Inc.

President: Dr. Dean M. Lierle, State University of Iowa, Iowa City.
Secretary: Dr. Lawrence R. Boies, University Hospitals, Minneapolis 14.
Place: Fairmont Hotel, San Francisco. Time: May 17-18, 1958.
Place: The Homestead, Hot Springs, Va. Time: 1959.

American Otorhinologic Society for Plastic Surgery, Inc.

President: Dr. Armand L. Caron, 36 Pleasant St., Worcester, Mass.
Secretary: Dr. Louis Joel Feit, 66 Park Ave., New York 16.

American Society of Facial Plastic Surgery

President: Dr. Irvin J. Fine, 505 New Brunswick Ave., Perth Amboy, N. J.
Secretary: Dr. Samuel M. Bloom, 123 E. 83rd St., New York 28.

American Society of Ophthalmologic and Otolaryngologic Allergy

President: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis 3.
Secretary-Treasurer: Dr. Michael H. Barone, 468 Delaware Ave., Buffalo 2.

Otosclerosis Study Group

President: Dr. Joseph A. Sullivan, 174 St. George St., Toronto 5, Canada.
Secretary-Treasurer: Dr. Arthur L. Juers, 611 Brown Building, Louisville.

Society of Military Otolaryngologists

President: Capt. William C. Livingood, U. S. N. (MC).
Secretary-Treasurer: Lt. Col. Stanley H. Bear, USAF(MC), 3810th USAF Hospital, Maxwell AFB, Alabama.

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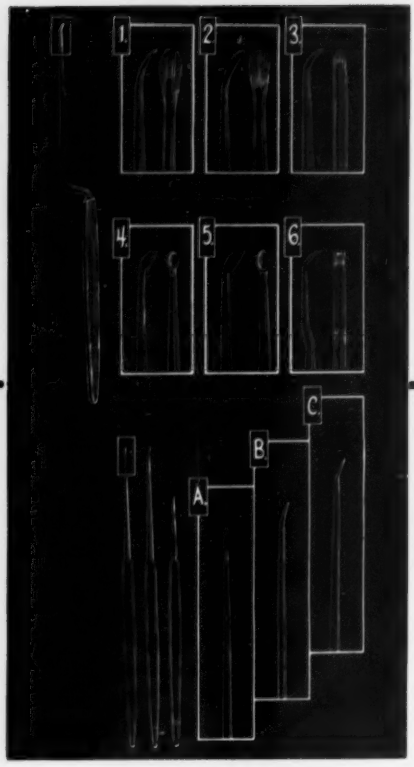

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Ref. Archives of Otolaryngology, February 1953

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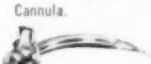

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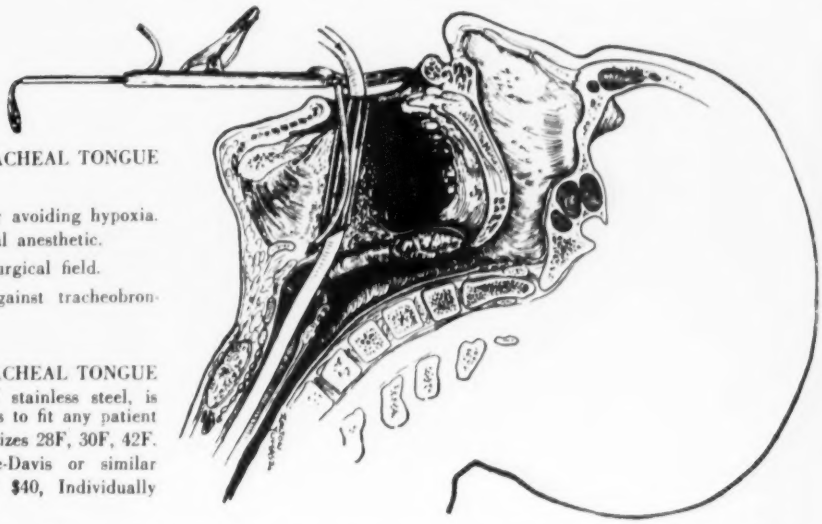

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*Barton, R. T.: Instrument for endotracheal anesthesia during oro-pharyngeal surgery. J. A. M. A. 153:1017 (Nov. 14) 1953.

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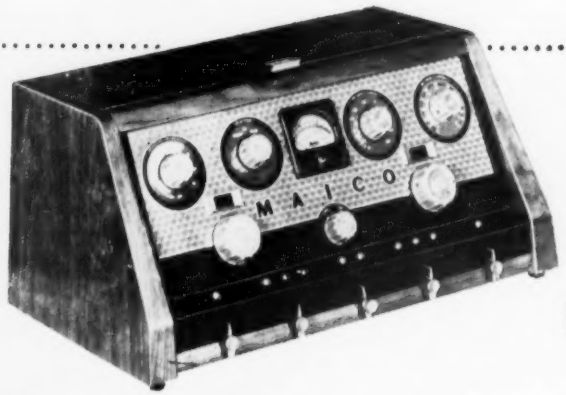

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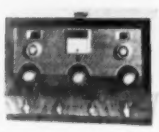

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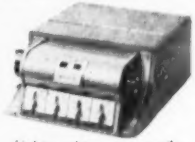

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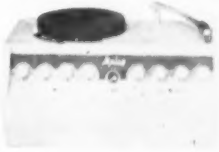

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